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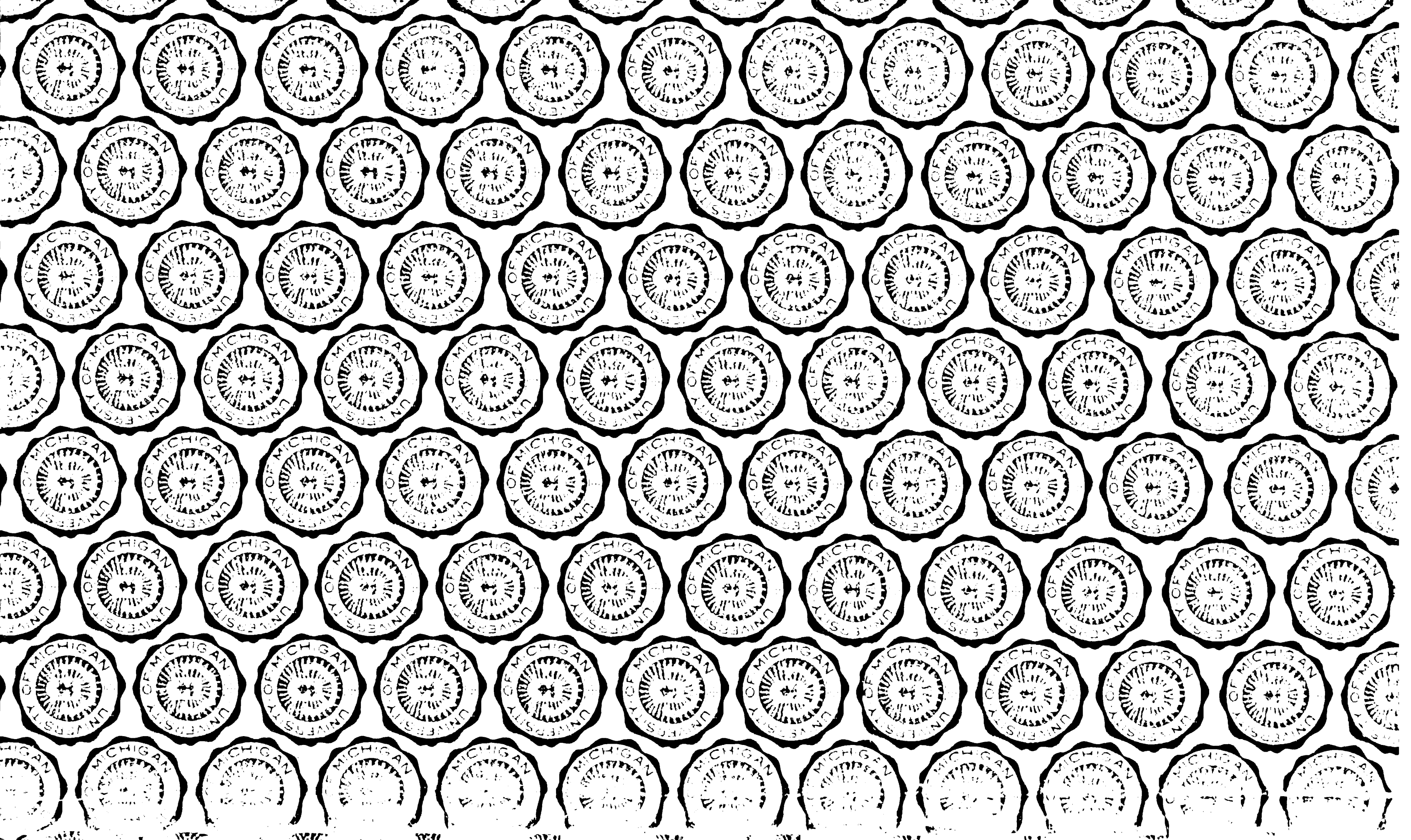
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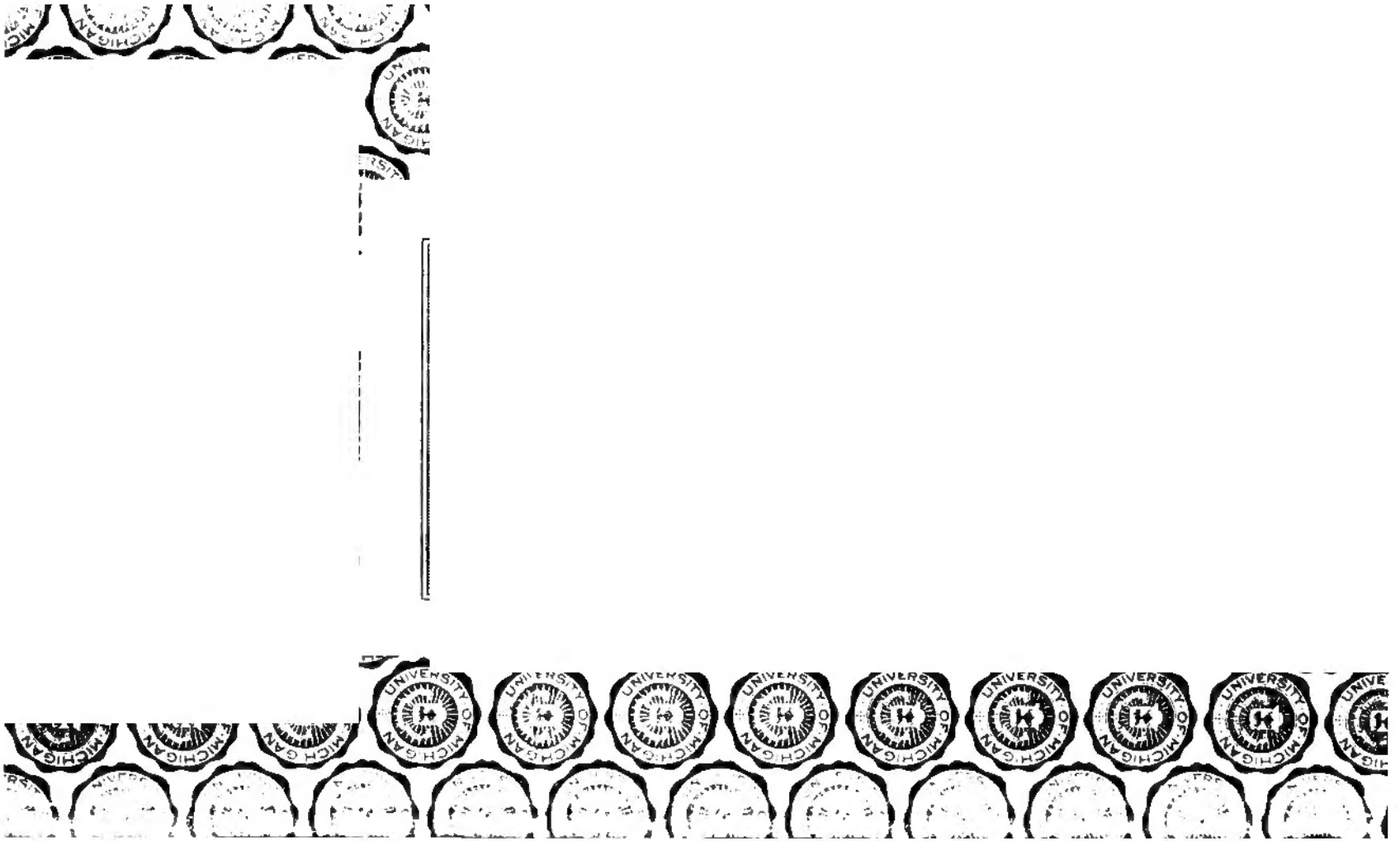

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Tariff Information Series—No. 15

Costs of Production in the Dye Industry 1918 and 1919

Details of Costs for a Selected List of Dyes and Intermediates

INGTON
TING OFFICE

UNITED STATES TARIFF COMMISSION.

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INTRODUCTION.

This report, issued as one among the publications of the United States Tariff Commission on industries affected by the tariff, is divided into two parts:

First. A study of the cost of production of a selected list of dyes and intermediates for the last half of 1918 and the first three quarters of 1919: Statistical tables are given showing (1) the costs of production of dyes and intermediates in dollars per pound; (2) costs in 1919 in relation to 1918 figures; (3) analysis of costs for the periods; (4) variations of costs by companies for the third quarter of 1919; (5) details of overhead expenses for third quarter of 1919; and (6) miscellaneous special charges for third quarter 1919.

Second. A comparison of domestic costs in the third quarter of 1919 with the prices of dyes and intermediates in various markets at different periods: Statistical tables are given showing (1) a comparison of costs with prewar and present prices for dyes and intermediates; (2) relative prices of a selected list of dyes compared with prewar prices.

The Commission has had the services of Geo. P. Comer and Arthur R. Willis, special experts, of the Commission's staff in the preparation of this pamphlet.

COSTS OF PRODUCTION IN THE DYE INDUSTRY, 1918 AND 1919.

In May, 1919, the United States Tariff Commission held a conference with the accounting representatives of the important dye manufacturers of this country and discussed the methods of conducting a cost investigation in the dye industry.

At this meeting it was decided that costs should be submitted for the last half of 1918 and the first quarter of 1919 upon a selected list of dyes and intermediates. This information was received by the commission, but after it was analyzed and tabulated it was found that the data did not cover a sufficiently long period of time to show the cost tendencies in the industry. It was therefore decided to obtain also the cost reports for the second and third quarters of 1919.

With the cooperation of the manufacturers in the industry the cost reports for these later periods have been received, tabulated, and verified on the books of most of the companies reporting, and the Tariff Commission is now able to put before Congress the results of this investigation covering the period from July, 1918, to September, 1919, inclusive.

In presenting these figures of cost, however, the Tariff Commission desires to point out that the averages here submitted do not represent the condition of the industry in as accurate a manner as the average costs usually represent industries that are long established and that have well-tested and standardized methods both of production and of cost accounting.

The fundamental idea upon which the following tables are based is that the cost records as kept by the reporting companies shall be accepted as the accounting facts in the case without revision by the commission. It is true some uniformity in the reports has been introduced by our methods of tabulation, but in the main the averages were compiled from figures actually found to be upon the books of records as kept by the various companies.

Peculiarities of various items of expense will be pointed out in the detailed discussion of the tables, but a preliminary statement of possible errors is necessary here.

There are two kinds of difficulties in this particular industry which render conclusions based upon average cost figures of doubtful value.

The first is that the manufacturing methods in the industry are not well organized and are not reduced to a normal routine. To a considerable extent the production in the past has proceeded almost regardless of cost. As with most of the war industries, the question of quantity output and prompt deliveries was of primary importance, and attention was diverted from the nicer adjustments that characterize routine operations. In many cases the management of particular plants thought it wiser to build full-sized productive units upon the chance that they would be successful in operation rather than to go through a long process of building small "semiplants,"

or "pilot" plants as they are sometimes called, where the engineering and chemical problems are worked out before quantity production is attempted. In many cases, also, the haste with which operations were carried on led to abnormal costs through low yields from the material consumed, or through the spoiling of valuable products by inexperienced or careless operators. Not only has this lack of organization of the productive processes led to great discrepancies in the cost between different firms but it also has led to great variations in the cost for a given product at different periods for the same plant. Many of the tendencies toward lower cost of production due to a greater output have been hidden, therefore, by fortuitous circumstances connected with the productive processes.

The second difficulty that renders average costs unreliable is the fact that uniform methods of accounting have not been applied in the industry. This is especially true with respect to the distribution of overhead expenses to the various products. Because of the large capital investment necessary in the dye industry the overhead charges are relatively large as compared with the direct labor cost. Therefore differences in the method of distributing them have a great influence upon the apparent cost of particular products.

Without going into the details of the various methods of distribution of expenses we may mention the following that are in use:

(*a*) Distribution upon the basis of the direct labor. That is to say, if all the overhead expenses for the dye factory are, say, 50 per cent of the total direct labor cost, a given product which has labor cost of $1 should have an overhead charge of 50 cents.

(*b*) Distribution based upon the cost of the raw material used in a given product as compared with the total raw material used in the plant.

(*c*) Distribution based upon the direct superintendence chargeable to a particular product.

(*d*) Distribution upon the basis of the relative sales value of the products.

(*e*) Still another method in use, and one that seems to be particularly well suited to the dye industry, is a distribution upon the basis of capital investment in the various productive divisions of the plant. That is to say, if a given product or class of related products requires a capital investment of 10 per cent of the whole value of assets this product or class should bear 10 per cent of the overhead burden.

No attempt will be made here to explain these various methods of distribution, nor was any attempt made to reconcile the differences in cost growing out of them in tabulating the reports as received. It is probable that some uniform method could have been applied, but because of the great diversity in the manufacturing and accounting methods of the various firms any scheme of distribution applicable to all reports would have been crude and arbitrary and likely to involve more errors than it corrected.

Another class of cost that is especially irregular upon the reports of the various companies is that of selling expenses, and they have been excluded from the report except in the case of one company where it was impossible to separate them from administrative charges.

In view of the unstandardized and varying methods of production and of accounting in this industry the Tariff Commission must

strongly emphasize the uncertainty of conclusions drawn from the cost figures in this report, and the possibility of error in administrative action based upon such data. The figures, are, however, the most trustworthy and the most significant that can be immediately procured under present conditions in the industry, and in any discussion of the cost of production the following tables must be accepted as the nearest approach to accuracy now possible.

TABLE I.

Table I shows the average cost per pound of certain dyes and intermediates for the last half of 1918 and for each of the first three quarters of 1919. The average cost per pound has been obtained by taking the aggregate of the pounds produced of a particular product for all companies reporting and dividing it into the aggregate costs for the same product. In this manner unit costs are weighted according to the quantity produced. That is to say, the costs for a company with a large output has a greater influence upon the average cost per pound than those for a company whose production is small.

TABLE I.—*Cost of production of a selected list of dyes and intermediates.*[1]

[Dollars per pound.]

Product.	Average cost per pound.			
	1 Last half of 1918.	2 First quarter 1919.	3 Second quarter 1919.	4 Third quarter 1919.
Intermediates:				
Acetanilid	0.4022	0.3368	0.3800	0.4024
Anilin	.3460	.3361	.2426	.2412
Benzaldehyde	1.6109	1.3338	.....	.....
Benzidin	1.0767	.9848	1.6216	1.2139
Benzoic acid	1.3905	.8931	.....	.....
Beta naphthol	.6286	.5049	.4343	.3148
Dianisidin	7.8353	9.2999	5.9850	3.4966
Dimethylanilin	.4943	.4604	.5173	.4829
Dinitrobenzol	.2961	.2755	.2837	.2865
H-acid	1.0267	1.0682	.7110	1.1893
Metaphenylenediamin	1.1359	.9732	1.0312	1.5165
Nitrobenzol	.1476	.1168	.1085	.1047
Ortho-toluidin	1.0034	.7958	.8220	.5491
Paranitranilin	1.1974	.9431	.6778	.8459
Paratoluidin	1.4815	1.0202	.7726	.5406
Phthalic anhydride	5.3524	2.5226	1.3814	1.2928
Dyes:				
Benzo blue 2B	.7324	.5808	1.5137	1.0714
Bismarck brown	1.4177	1.1190	.9915	1.1382
Chrysoidine	1.2836	.8623	.8344	.7476
Direct black	.5344	.4271	.8149	.6965
Indigo	.7206	.8733	.7577	.6306
Magenta	3.8894	5.6993	5.5420	5.8234
Malachite green	5.5410	5.3262	.....	.....
Methylene blue	2.3640	2.3292	2.2785	2.1359
Methyl violet	2.2536	1.8101	1.7130	1.8102
Naphthylamine black	.9080	.8013	1.1976	.8773
Crude nigrosine	.....	.6532	.....	.....
Refin nigrosine	.7109	.....	.....	.....
Nigrosine (finished)	.....	.4979	.5640	.5307
Orange II	.7345	.5685	.6242	.6077
Sulphur black	.4432	.4177	.3539	.3009

[1] These costs are the weighted average cost for 2 to 5 companies reporting upon each product.

TABLE I–A.

Table I–A shows the same items of cost expressed in percentages with the average unit cost of each product for the last half of 1918 as the base or 100 per cent. From this table it will be seen that the costs of intermediates have in general been falling and that the costs of dyes, especially in the later period of 1919, have been rising. Why these two divergent tendencies should manifest themselves in the cost of two classes of products as closely related as are intermediates and dyes is an interesting question but one that can not be answered with any certainty from data now available. However, some factors involved in the solution that may throw some light upon the question may be pointed out. An examination of cost figures, especially of intermediates, shows that the products (such as anilin, beta naphthol, and nitrobenzol) that are produced in large quantities and under routine processes have successively lower costs in each period since 1918. The "law of increasing returns" seems to apply in these cases and from the causes which underlie the tendency to lower cost we may predict that as the industry develops more and more products will be produced under such conditions.

The same tendencies are shown, when the individual cost sheets are studied, in the case of many dyes of large production, such as sulphur black, orange II, indigo, and direct black, but the average cost figures do not show this tendency in all cases because of accidental circumstances affecting the costs for particular companies. For example, in the case of orange II, one company had some "off color" runs which inflated their costs greatly and kept up the average for all companies higher than it otherwise would have been. Direct black and benzo blue 2B show inconsistencies in costs in various periods largely because of the fact that an important constitent of both dyes, H-acid, is not being produced satisfactorily by all companies. In some plants H-acid costs several times as much as in other plants, and when the abnormal expense is carried over into dyes they themselves show a high cost for the given company, no matter how standardized their processes of production may be.

Other instances of rising costs of dyes are not so easily explained, but it is possible that in some cases the processes are not sufficiently standardized to permit of economical production upon a large scale, even though small quantities may be produced at a reasonable figure.

TABLE I–A.—*Cost of production of a selected list of dyes and intermediates.*[1]

[Comparative costs in percentages.]

Product.	1 Last half of 1918.	2 First quarter 1919.	3 Second quarter 1919.	4 Third quarter 1919.
Intermediates:	*Per cent.*	*Per cent.*	*Per cent.*	*Per cent.*
Acetanilid	100	83	94	100
Anilin	100	97	70	69
Benzaldehyde	100	82	.....	.....
Benzidin	100	91	150	112
Benzoic acid	100	64	.....	.....
Beta naphthol	100	80	69	50
Dianisidin	100	118	76	44
Dimethylanilin	100	203	104	97
Dinitrobenzol	100	93	95	96

[1] These costs are the weighted average cost for 2 to 5 companies reporting upon each product.

TABLE I–A.—*Cost of production of a selected list of dyes and intermediates*—Continued.

Product.	1 Last half of 1918.	2 First quarter 1919.	3 Second quarter 1919.	4 Third quarter 1919.
Intermediates—Continued.	*Per cent.*	*Per cent.*	*Per cent.*	*Per cent.*
H-acid	100	104	69	115
Metaphenylenediamin	100	85	90	133
Nitrobenzol	100	79	73	71
Ortho-toluidin	100	79	81	54
Paranitranilin	100	78	56	70
Paratoluidin	100	68	52	36
Phthalic anhydride	100	47	25	24
Dyes:				
Benzo blue 2B	100	79	206	146
Bismark brown	100	78	69	80
Chrysoidine	100	67	65	58
Direct black	100	79	152	130
Indigo	100	121	105	100
Magenta	100	146	142	149
Malachite green	100	96	.....	.....
Methylene blue	100	98	96	90
Methyl violet	100	80	76	80
Naphthylamine black	100	88	131	96
Crude nigrosine	.....	.....	.....	.....
Rein nigrosine	100	.....	.....	.....
Nigrosine (finished)	.....	100	113	106
Orange II	100	77	84	81
Sulphur black	100	94	79	67

TABLE II.

In Table II are shown some of the elements of cost classified under the heads of "Material," "Direct labor," "Overhead," and "All other."

Material.—Attention is called to the fact that the cost of material listed here does not represent the cost of basic raw materials such as coal tar, sulphuric acid, and fuel, but rather it is the cost of intermediates, which are themselves highly elaborated products. It therefore follows that the cost of material involves considerable labor costs in previous processes of manufacture. Some information has been received as to the labor involved in manufacturing dyes from the crude material through the various intermediate stages up to the finished product, but the data are not sufficiently comprehensive to justify their incorporation in this report.

Another point that should be noted in connection with the cost of material is the fact that the values of intermediates, whether purchased or manufactured, are taken at their cost to the various companies reporting. If a company manufactures its own intermediates they are listed at cost in the further processes of manufacture. If it buys them in the open market, they are listed at the purchase price in calculating the cost of dyes made from them.

At first glance it may seem that such a procedure is open to objections upon the grounds that the costs from various companies are not comparable where both methods of valuation of materials are used. In a sense this is true, but only because the manufacturing conditions themselves are not exactly comparable. If one firm manufactures its intermediates, we may assume that it can do so cheaper than it can buy them; whereas if another company purchases them, the presumption is that the price is lower than would be its cost of manufacturing them. From this it follows that to increase the valuation of intermediates for one firm by an amount equal to the difference between its cost and market value or to reduce the

valuation used by the other firm by the difference between the market value and a purely hypothetical cost of production is to run counter to the actual cost facts in the case. If one firm is fortunate enough to be able to produce intermediates cheaper than the market price, or if another is so situated that the open market offers its best source of supply, on the whole we are not justified in applying to the two companies a leveling factor that does not actually exist.

As a matter of fact in the particular case of the dye industry the small firm may be able to purchase its intermediates about as cheaply as other dye manufacturers can make them, because certain companies specialize in intermediates, and therefore are able to sell them relatively cheap. The larger firms, which manufacture them for their own use, gain something by being self-sustaining and independent of the market, but perhaps lose something by way of a higher cost; or at least they may not be able to make a profit upon both dyes and intermediates until their volume of production offsets the higher cost due to a great variety of products.

Direct labor.—Little comment is necessary upon the item of direct labor given in Table II. It will be seen that it constitutes a small part of the cost of the finished product. These figures, of course, do not represent all the labor cost involved in the manufacture of dyes; first, because the cost of material includes much labor cost in making the intermediates, and, second, because considerable labor, usually called "indirect labor," is charged in the column of "Overhead" expenses.

The same idea may be expressed in other terms by saying that the complexity of the industry is so great and the capital investment in machinery and equipment for a given process is so large that there are practically no hand processes of production, and that relatively little of the total labor cost may be charged directly to a particular product

It is not to be supposed, however, that these conditions render labor unimportant in the process of manufacture. Indeed, although it is true that the processes are carried on chiefly by machinery, the responsibility resting upon the labor force is greater than under conditions of hand labor, because of the valuable material and equipment used. A slight mistake in controlling chemical reactions may cause the loss of thousands of dollars worth of products or machinery. So true is this that one of the most important assets in the dye industry is a skilled labor force whose senses are trained to detect subtle changes in the productive processes whereby the maximum efficiency of the plant and the greatest yield from the raw materials may be obtained.

Overhead expenses.—The term "overhead," as used in this report, includes various classes of expense, such as "works expense," "fixed charges," and "administrative expense."

Works expense is composed of such items as fuel, water, supplies, repairs, sundry, and indirect labor. In short, it is made up of those expenses that vary somewhat directly with the volume of production.

Fixed charges are composed of depreciation, taxes (State or local), rentals, insurance, and in some cases interest; that is to say, of those expenses which do not vary with the volume of output.

Administrative expense represents the proportional share of the general office expense, including administrative salaries, chargeable to the dye department.

All other.—In addition there are numerous other expenses to be accounted for in various ways which we have included in the category of "All other."

TABLE II.—*Analysis of costs by periods.*

[Dollars per pound.]

Product.	Period.	Average per pound.				
		1 Material.	2 Direct labor.	3 Over-head.	4 All other.	Total.
INTERMEDIATES.						
Acetanilid	Last half 1918	0.3399	0.0117	0.0450	0.0056	0.4022
	First quarter 1919	.2576	.0147	.0644	.0001	.3368
	Second quarter 1919	.2613	.0163	.1009	.0015	.3800
	Third quarter 1919	.2834	.0144	.1028	.0018	.4024
Anilin	Last half 1918	.2107	.0149	.0770	.0134	.3460
	First quarter 1919	.1925	.0379	.0826	.0231	.3361
	Second quarter 1919	.1586	.0132	.0580	.0128	.2426
	Third quarter 1919	.1543	.0116	.0565	.0188	.2412
Benzaldehyde	Last half 1918	.7427	.2962	.5820	.....	1.6109
	First quarter 1919	.6048	.3116	.3644	.0530	1.3338
	Second quarter 1919	.....	.....	.....	.....	.....
	Third quarter 1919	.....	.....	.....	.....	.....
Benzidin	Last half 1918	.6600	.0687	2116	.1364	1.0767
	First quarter 1919	.5397	.0734	.2888	.0829	.9848
	Second quarter 1919	.8678	.0944	.5240	.1354	1.6216
	Third quarter 1919	.6478	.0966	.3711	.0984	1.2139
Benzoic acid	Last half 1918	.6368	.2286	.5271	.....	1.3905
	First quarter 1919	.4078	.2280	.2573	.....	.8931
	Second quarter 1919	.....	.....	.....	.....	.....
	Third quarter 1919	.....	.....	.....	.....	.....
Beta naphthol	Last half 1918	.2750	.0681	.2361	.0494	.6286
	First quarter 1919	.2180	.0528	.2086	.0255	.5049
	Second quarter 1919	.1712	.0511	.1924	.0196	.4343
	Third quarter 1919	.1504	.0375	.1222	.0047	.3148
Dianisidin	Last half 1918	7.1520	.3290	.3513	.....	7.8353
	First quarter 1919	7.0653	.7782	1.4564	.....	9.2999
	Second quarter 1919	4.4601	.4086	.9267	.1396	5.9350
	Third quarter 1919	2.6610	.2098	.5622	.0636	3.4966
Dimethylanilin	Last half 1918	.3484	.0155	.0788	.0516	.4943
	First quarter 1919	.3324	.0223	.0874	.0183	.4604
	Second quarter 1919	.3807	.0182	.0867	.0317	.5173
	Third quarter 1919	.3508	.0158	.0851	.0312	.4829
Dinitrobenzol	Last half 1918	.1861	.0134	.0640	.0326	.2961
	First quarter 1919	.1532	.0185	.0885	.0153	.2755
	Second quarter 1919	.1479	.0141	.1004	.0213	.2837
	Third quarter 1919	.1636	.0114	.0867	.0248	.2865
H-acid	Last half 1918	.4990	.0781	.3029	.1467	1.0267
	First quarter 1919	.4430	.0743	.4694	.0815	1.0682
	Second quarter 1919	.3075	.0402	.3277	.0356	.7110
	Third quarter 1919	.6621	.0621	.3936	.0715	1.1893
Metaphenylenediamin	Last half 1918	.6907	.0389	.2316	.1747	1.1359
	First quarter 1919	.6155	.0431	.2183	.0963	.9732
	Second quarter 1919	.6849	.0687	.2232	.0544	1.0312
	Third quarter 1919	.7908	.1135	.5842	.0280	1.5165
Nitrobenzol	Last half 1918	.1029	.0040	.0220	.0187	.1476
	First quarter 1919	.0947	.0042	.0069	.0110	.1168
	Second quarter 1919	.0810	.0033	.0184	.0058	.1085
	Third quarter 1919	.0764	.0028	.0180	.0075	.1047
Ortho-toluidin	Last half 1918	.6472	.0609	.2115	.0839	1.0034
	First quarter 1919	.4987	.0436	.2050	.0486	.7958
	Second quarter 1919	.6286	.0353	.1308	.0273	.8220
	Third quarter 1919	.4130	.0215	.0936	.0210	.5491
Paranitranilin	Last half 1918	.7965	.0593	.2359	.1057	1.1974
	First quarter 1919	.5720	.0485	.2567	.0659	.9431
	Second quarter 1919	.3986	.0494	.2241	.0057	.6778
	Third quarter 1919	.6237	.0399	.1804	.0019	.8459
Paratoluidin	Last half 1918	.8179	.1141	.3531	.1964	1.4815
	First quarter 1919	.5777	.0424	.1725	.2276	1.0202
	Second quarter 1919	.5829	.0332	.1469	.0096	.7726
	Third quarter 1919	.3931	.0264	.1011	.0200	.5406
Phthalic anhydride	Last half 1918	2.0908	.3717	2.6598	.2301	5.3524
	First quarter 1919	1.3763	.1902	.9561	.....	2.5226
	Second quarter 1919	.9284	.0795	.3735	.....	1.3814
	Third quarter 1919	.....	.....	.....	.....	.....

TABLE II.—*Analysis of costs by periods*—Continued.

Product.	Period.	Average per pound.				
		1 Material.	2 Direct labor.	3 Over-head.	4 All other.	5 Total.
DYES.						
Benzo blue 2B	Last half 1918	0.5321	0.0221	0.1267	0.0515	0.7324
	First quarter 1919	.4039	.0131	.1268	.0370	.5808
	Second quarter 1919	1.2766	.0402	.1711	.0258	1.5137
	Third quarter 1919	.8234	.0474	.1721	.0285	1.0714
Bismarck brown	Last half 1918	.8272	.0558	.2969	.2378	1.4177
	First quarter 1919	.7365	.0713	.2741	.1081	1.1190
	Second quarter 1919	.5448	.0466	.2931	.1070	.9915
	Third quarter 1919	.7300	.0679	.2598	.0805	1.1382
Chrysoidine	Last half 1918	.5923	.0940	.5214	.0759	1.2836
	First quarter 1919	.4565	.0566	.2842	.0650	.8623
	Second quarter 1919	.3918	.0564	.3166	.0696	.8344
	Third quarter 1919	.4179	.0346	.2062	.0889	.7476
Direct black	Last half 1918	.3278	.0123	.0949	.0994	.5344
	First quarter 1919	.3296	.0138	.0239	.0598	.4271
	Second quarter 1919	.5654	.0256	.1749	.0490	.8149
	Third quarter 1919	.4465	.0223	.1630	.0647	.6965
Indigo	Last half 1918	.4666	.0680	.1840	.0020	.7206
	First quarter 1919	.5715	.0563	.1943	.0512	.8733
	Second quarter 1919	.4743	.0447	.2041	.0346	.7577
	Third quarter 1919	.3788	.0403	.1866	.0251	.6308
Magenta	Last half 1918	2.6262	.4249	.7639	.0744	3.8894
	First quarter 1919	2.5274	.6268	2.5451	.....	5.6993
	Second quarter 1919	2.8599	.5515	2.0569	.0737	5.5420
	Third quarter 1919	3.5650	.5345	1.6974	.0265	5.8234
Malachite green	Last half 1918	4.5545	.3325	.3765	.2775	5.5410
	First quarter 1919	2.8605	.2993	2.1664	.....	5.3262
	Second quarter 1919	.....	.....	.....	.....	.....
	Third quarter 1919	.....	.....	.....	.....	.....
Methylene blue	Last half 1918	1.6527	.1211	.3965	.1937	2.3640
	First quarter 1919	1.4804	.1613	.5692	.1183	2.3292
	Second quarter 1919	1.2614	.1355	.7028	.1788	2.2785
	Third quarter 1919	1.4449	.1229	.4718	.0963	2.1359
Methyl violet	Last half 1918	1.1099	.2005	.8234	.1198	2.2536
	First quarter 1919	.8261	.1459	.6602	.1779	1.8101
	Second quarter 1919	.8734	.0959	.5677	.1760	1.7130
	Third quarter 1919	.8131	.1400	.7057	.1514	1.8102
Naphthylamine black	Last half 1918	.5538	.0283	.1550	.1709	.9080
	First quarter 1919	.4667	.0288	.2010	.1048	.8013
	Second quarter 1919	.7069	.0364	.2639	.1904	1.1976
	Third quarter 1919	.5182	.0294	.2264	.1033	.8773
Nigrosine (finished)	Last half 1918	.....	.....	.....	.....	.....
	First quarter 1919	.3118	.0111	.1100	.0650	.4979
	Second quarter 1919	.3108	.0191	.1473	.0868	.5640
	Third quarter 1919	.2992	.0167	.1297	.0851	.5307
Orange II	Last half 1918	.4544	.0389	.1735	.0677	.7345
	First quarter 1919	.3452	.0399	.1532	.0302	.5685
	Second quarter 1919	.3310	.0465	.2246	.0221	.6242
	Third quarter 1919	.3624	.0393	.1969	.0021	.6007
Sulphur black	Last half 1918	.2399	.0282	.1116	.0635	.4432
	First quarter 1919	.2185	.0269	.1367	.0356	.4177
	Second quarter 1919	.1823	.0209	.1243	.0264	.3539
	Third quarter 1919	.1427	.0170	.1161	.0251	.3009

TABLE II–A.

Table II–A is especially important in estimating the reliability of the average cost figures given in Tables I and II.

In this table an attempt is made to show by means of percentages the range of costs for particular products as reported by various companies. It is impossible to give the actual cost figures of the individual companies because of the probability of the identification of particular concerns. Further, to prevent identification of individual producers the products are given by number instead of by name and are arranged in a haphazard manner. Moreover, no distinction is made between dyes and intermediates in the arrangement of this table.

In column 1 will be found the relative quantity of output for a particular product by the various companies, the total of which

equals 100. In subsequent columns are found the range of costs based upon the average cost as 100 per cent.

Attention is called to the fact that the range of costs of material is almost as great as for direct labor and overhead expenses. This is due to the peculiar nature of the dye industry that has been mentioned above, namely, that the materials used in the production of both dyes and intermediates may themselves be highly elaborated products. Their value as incorporated in subsequent processes is subject therefore to a great number of cost variations during the several steps necessary for their manufacture. Moreover, the fact that many of the intermediates are made by the same plants that produce the dyes causes a greater irregularity in the valuation of intermediates than would be the case if there was a regular market for them in which all manufacturers made their purchases.

The direct labor column also shows great variations among the costs for different companies. This is explainable upon the grounds that direct labor is relatively a small part of the total cost of production because of the complex nature of the industry and the predominance of machine processes. Furthermore, the amount of direct labor that may be charged to a particular product is somewhat arbitrary, because in one plant some products may be produced under such conditions that most of the labor can be charged directly to them, whereas in another plant the same products may be produced in a manufacturing unit along with several other colors and relatively little labor may be charged directly to any one of them. However, after allowances are made for the different accounting methods, the fact remains that it is not uncommon for the direct labor charges to vary 100 per cent.

The column of overhead expense likewise shows great variation. This is due, to some extent perhaps, to various methods of distributing overhead expenses, but more especially to an actual difference in expenses incurred by the various concerns reporting.

The variations in the column marked "All other" are not significant, because the charges shown in this column are miscellaneous and may be large or small according to whether or not the sundry items could be distributed to other classes of expense.

The variations in the column marked "Total" are more important than the details given in the other columns. In some cases the difference in direct labor may be offset by contra variations in one of the other columns, but in the column representing total costs are shown the fundmental differences among the several plants. Variations running from 50 to 200 per cent of the average cost for particular products are not uncommon. Moreover, there is no unmistakable relation between costs and quantity of output. Not only is there a great difference in the costs of a given product as between two companies having about the same volume of output, but also some companies producing two products in large quantities may show a relatively high cost for one and a relatively low cost for the other.

There are reasons to believe that as the industry develops successively lower costs will come with increasing output, but the conditions in the past, wherein quantity production has been forced almost regardless of cost, hide the tendencies to such an entent that most generalizations with respect to the future of the industry can not be based upon present cost facts.

TABLE II–A.—*Variations of costs by companies for third quarter of 1919.*

[In column 1 the base (100 per cent) is the total output of each product for all companies reporting. In the other columns the base is the average cost for the various classes of expenses for all companies.]

Product.	1 Production by companies.	2 Material.	3 Direct labor.	4 Overhead.	5 All other.	6 Total.
	Per cent.	*Per cent.*	*Per cent.*	*Per cent.*	*Per cent.*	*Per cent.*
(1)	73	98	110	123	122	109
	27	42	72	37	39	75
	100	.....	.....	.....	.....	.....
(2)	14	45	99	65	.....	49
	39	142	142	132	32	136
	24	92	89	138	351	109
	23	69	42	24	6	58
	100	.....	.....	.....	.....	.....
(3)	11	117	149	121	.....	121
	78	94	88	77	127	87
	5	129	175	288	.....	195
	6	121	105	203	.....	149
	100	.....	.....	.....	.....	.....
(4)	3	99	207	67	.....	83
	10	217	94	124	175	184
	87	86	97	98	94	90
	100	.....	.....	.....	.....	.....
(5)	9	223	152	284	.....	223
	17	176	132	114	49	157
	23	85	107	168	373	112
	51	61	77	33	10	54
	100	.....	.....	.....	.....	.....
(6)	21	70	138	95	.....	79
	75	84	54	64	17	73
	4	605	822	877	2,381	770
	100	.....	.....	.....	.....	.....
(7)	39	115	120	120	88	116
	61	90	87	87	107	90
	100	.....	.....	.....	.....	.....
(8)	5	270	113	247	12	231
	18	70	191	136	145	109
	34	97	59	23	.....	58
	43	96	94	130	169	115
	100	.....	.....	.....	.....	.....
(9)	72	101	86	92	139	102
	28	99	135	122	.....	95
	100	.....	.....	.....	.....	.....
(10)	27	88	44	56	.....	78
	20	94	66	71	.....	87
	7	101	425	224	1,350	149
	46	109	96	12	.....	111
	100	.....	.....	.....	.....	.....
(11)	18	106	50	27	.....	67
	21	78	155	93	.....	85
	5	107	372	153	2,064	134
	4	243	132	76	223	202
	52	94	69	125	.....	99
	100	.....	.....	.....	.....	.....
(12)	61	102	43	38	40	82
	22	118	234	204	120	144
	17	67	131	187	292	107
	100	.....	.....	.....	.....	.....

TABLE II–A.—*Variations of costs by companies for third quarter of 1919*—Continued.

Product.	1 Production by companies.	2 Material.	3 Direct labor.	4 Overhead.	5 All other.	6 Total.
	Per cent.	*Per cent.*	*Per cent.*	*Per cent.*	*Per cent.*	*Per cent.*
(13)	1	119	67	72	.....	91
	29	101	179	99	47	102
	51	95	63	105	151	101
	19	110	81	88	47	96
	100	.....	.....	.....	.....	.....
(14)	3	64	170	163	.....	83
	4	45	80	101	.....	55
	56	147	149	117	65	140
	33	30	18	74	189	41
	4	97	72	40	13	85
	100	.....	.....	.....	.....	.....
(15)	8	318	497	139	24	254
	88	77	57	97	111	84
	4	163	226	83	13	132
	100	.....	.....	.....	.....	.....
(16)	18	21	35	14	56	20
	44	98	48	82	.....	88
	38	50	46	103	.....	65
	100	.....	.....	.....	.....	.....
(17)	7	90	80	75	.....	84
	16	108	21	21	371	75
	6	319	190	106	624	242
	71	80	112	120	.....	95
	100	.....	.....	.....	.....	.....
(18)	27	8	8	7	2	7
	8	32	18	11	6	23
	65	8	10	11	14	9
	100	.....	.....	.....	.....	.....
(19)	27	104	176	144	.....	116
	73	99	71	83	138	94
	100	.....	.....	.....	.....	.....
(20)	27	92	82	53	26	80
	22	88	100	46	16	76
	2	111	210	125	.....	110
	41	110	89	163	214	125
	6	105	217	46	.....	90
	2	154	82	220	108	160
	100	.....	.....	.....	.....	.....
(21)	39	141	149	75	24	118
	9	118	70	110	177	118
	52	66	68	117	144	83
	100	.....	.....	.....	.....	.....
(22)	29	79	91	53	19	69
	22	87	110	62	18	77
	43	118	89	154	207	132
	6	113	187	75	.....	99
	100	.....	.....	.....	.....	.....
(23)	61	89	131	106	113	98
	39	118	52	91	79	103
	100	.....	.....	.....	.....	.....
(24)	1	195	173	283	.....	211
	23	196	67	71	30	139
	2	97	474	273	.....	169
	52	48	101	125	171	84
	22	113	96	43	20	84
	100	.....	.....	.....	.....	.....
(25)	47	93	104	83	30	88
	14	98	205	111	37	117
	39	109	58	81	206	108
	100	.....	.....	.....	.....	.....

TABLE III.

Table III is given for the use of those who are interested in the details of overhead expenses. The chief items constituting "Works expense," "Fixed charges," and "Administrative expense"[1] have been stated above in the discussion of overhead expense, and it is unnecessary to go into detail here. The column marked "Laboratory" includes the charges for the works control laboratory, which tests material and products in various stages of manufacture, and for the general experimental laboratory, which carries on countless experiments in the search for new products and for new raw materials. Strictly speaking, the expenses for these two laboratories should be shown separately, but their slight effects upon unit costs do not seem to justify the separation in this report.

For comparative purposes column 7 of Table III shows the percentage which overhead expense is of total costs.

TABLE III.—*Details of overhead expenses for third quarter of 1919.*

[Dollars per pound.]

Product.	1 Works expense.	2 Fixed charges.	3 Laboratory.	4 Administrative.	5 Other.	6 Total.	Per cent of total cost.
Intermediates:							
Acetanilid	0.0522	0.0294	0.0040	0.0049	0.0024	0.0929	24.01
Anilin	.0282	.0203	.0005	.0040	.0035	.0565	23.42
Benzidin	.1158	.1150	.0251	.0744	.0509	.3812	31.11
Beta naphthol	.0688	.0315	.0024	.0068	.0027	.1222	38.81
Dianisidin	.1630	.0588	.2793	.0356	.1406	.6773	16.64
Dimethylanilin	.0249	.0473	.0036	.0043	.0050	.0851	17.63
Dinitrobenzol	.0269	.0314	.0122	.0124	.0038	.0867	30.25
H-acid	.1763	.1413	.0280	.0806	.0291	.4553	36.66
Metaphenylenediamin	.1715	.4227	.0218	.0192	.0857	.7209	43.56
Nitrobenzol	.0064	.0077	.0002	.0010	.0024	.0177	17.02
Orthotoluidin	.0359	.0505	.0041	.0062	.0178	.1145	18.54
Paranitranilin	.1007	.0558	.0080	.0097	.0082	.1824	22.65
Paratoluidin	.0714	.0689	.0022	.0126	.0169	.1720	21.51
Phthalic anhydride	.0847	.....	.....	.0108	.....	.0955	7.39
Dyes:							
Benzo blue 2B	.0834	.0467	.0109	.0130	.0228	.1768	16.38
Bismark brown	.1002	.0831	.0113	.0456	.0196	.2598	22.83
Chrysoidine	.0547	.0972	.0208	.0269	.0066	.2062	27.58
Direct black	.0587	.0664	.0176	.0165	.0049	.1641	23.89
Indigo	.0904	.0526	.0185	.0099	.0152	.1866	29.58
Magenta	.6210	.6156	.2253	.1113	.1242	1.6974	29.15
Methylene blue	.1504	.1863	.0044	.0652	.0655	.4718	22.09
Methyl violet	.2870	.2701	.0138	.1134	.0214	.7057	38.99
Naphthylamine black	.0614	.1066	.0174	.0374	.0036	.2264	25.81
Nigrosine (finished)	.0382	.0650	.0080	.0179	.0006	.1297	24.44
Orange II	.0779	.1079	.0019	.0181	.0216	.2274	36.06
Sulphur black	.0447	.0350	.0196	.0151	.0017	.1161	38.58

Column 1, composed of fuel, power, supplies, repairs, etc.; column 2, composed of taxes, insurance, depreciation, etc.; column 3, composed of both the works and experimental laboratory expense; column 4, composed of general office expense chargeable to the dye department; column 5, composed of miscellaneous expenses not included in other classes of expense.

TABLE IV.

In Table IV are given further details of overhead expenses that are of special importance in cost analyses.

The item of depreciation shown in column 1 is perhaps more uncertain than any other element of cost. So uncertain is it that

[1] One item of interest included in administrative expense is that of managerial salaries. The commission received a statement of the 10 highest salaries chargeable to the dye department from each of the larger companies reporting. The highest salary paid to any official in any company was $20,000 per year. The usual pay of men in the chief managerial positions was from $9,000 to $12,000 per annum.

some companies have refused to consider it a part of cost of production and have charged the large replacements of equipment directly against profits.

In actual practice the rate of depreciation used in the accounts of various companies ranges from 20 to 33⅓ per cent for the most perishable classes of equipment and from 5 to 10 per cent for the more permanent kinds, such as buildings, engines, and boilers.

In column 2 of Table IV is shown the interest charges that are included in costs. Not only is the interest paid included but also in some cases an interest charge upon the value of equipment is added. The only excuse for such a procedure is based upon the assumption that this report shall contain only figures derived from the books of the several companies.

We may point out that consistency demands that if any interest is included in cost it should be calculated not upon fortuitous amounts of outstanding bonds, or notes whose quantities vary with the financial policy of the company, but upon the value of the assets necessary to conduct the business, regardless of whether they were purchased out of the proceeds of stock or bond issues, short-term notes, or out of earnings. If interest upon assets is not to be counted in costs neither should any interest paid upon mortgages, bonds, or notes be included.

In this report, however, no attempt is made to settle the propriety of treating interest as an element of cost, but, taking the facts as they are, it is attempted to show how significant the interest charge is if allowed at all.

The method of determining the unit figures in Table IV is of some importance, and unless outlined with care the figures may lead to erroneous conclusions.

At first glance it may be supposed that these averages were obtained by adding the total charges for, say, interest and dividing by the total production of a given product for all companies reporting an interest charge. Such a procedure, however, would defeat the purpose of the table—i. e., to show the influence of these special items upon the total unit cost of the product for the industry as a whole. If, for example, the average cost of an article is $1 per pound for all companies and the interest charge for the companies reporting interest is 5 cents a pound, one might suppose that interest was 5 per cent of the average unit cost for all companies, whereas, as a matter of fact, since few companies report interest, the aggregate interest charge may be less than 1 per cent of the total cost. In order to avoid this misconception, the total charge for any one of these special items is divided not by the total production of the companies reporting the item but by the aggregate production of the particular product for all companies.

Some of these special charges may be large elements in the unit cost of particular companies, but in the average unit cost for the industry as a whole they are not of primary importance. The total of them is by no means negligible, however, as will be seen from column 6 of Table IV, where in some cases they are 15 to 20 per cent of the total cost.

TABLE IV.—*Miscellaneous special charges for third quarter of 1919 (included in cost of production*[1]*).*

[Dollars per pound.]

Product.	1 Depreciation.	2 Interest.	3 Laboratory.	4 Sundry.	5 Total.	6 Per cent of total cost.
Intermediates:						
Acetanilid	0.0147	0.0136	.....	0.0064	0.0347	8.62
Anuhn	.0203	.0103	0.0005	.0063	.0374	15.50
Benzidin	.1068	.0432	.0115	.0146	.1761	14.51
Beta naphthol	.0083	.0079	.0017	.0130	.0309	9.82
Dianisidin	.0224	.....	.1072	.....	.1296	3.71
Dimethylanilin	.0369	.0172	.0043	.0137	.0721	14.98
Dinitrobenzol	.0315	.0134	.0005	.0062	.0516	18.01
H-acid	.1110	.0358	.0089	.0133	.1690	14.21
Metaphenylenediamin	.2944	.....	.0152	.....	.3096	20.42
Nitrobenzol	.0076	.0041	.0002	.0038	.0157	15.00
Orthotoluidin	.0390	.0102	.0006	.0038	.0536	9.76
Paranitranilin	.0355	.0305	.....	.0144	.0804	9.51
Paratoluidin	.0271	.0098	.....	.0044	.0413	7.64
Dyes:						
Benzo blue 2B	.0437	.0101	.0013	.0025	.0576	5.38
Bismark brown	.0862	.0405	.....	.0112	.1379	12.12
Chrysoidine	.....	.....	.....	.0326	.0326	4.36
Direct black	.0780	.0357	.0007	.0075	.1219	17.50
Indigo	.0549	.0123	.0163	.0064	.0899	14.23
Magenta	.2243	.1824	.1877	.3779	.9723	16.70
Methylene blue	.0703	.0420	.0089	.0615	.1827	8.55
Methyl violet	.1985	.0856	.....	.0287	.3128	17.28
Naphthylamine black	.1076	.0500	.....	.0101	.1677	19.11
Nigrosine (finished)	.0500	.0321	.....	.0037	.0858	16.16
Orange II	.0218	.....	.0004	.0787	.1009	16.81
Sulphur black	.0321	.0143	.0105	.0033	.0602	20.01

[1] The special items of cost appearing in this table are not reported by all companies, but in order to show the influence of these items upon the total cost given in previous tables the aggregate amount of each one of them for all companies reporting is divided not by the aggregate production of these companies, but by the aggregate production of all companies reporting upon each product, the method used in computing all averages in these tables.

TABLE V–A.

Table V–A shows the costs of intermediates for the third quarter of 1919 as compared with the market price in 1920 and the German prewar price in 1914.

The market price given in column 2 represents the simple average of prices per pound in 100-pound lots for various firms reporting to the commission.

Column 3 represents foreign invoice values of intermediates in 1914. These figures were taken from a report by Mr. Norton published by the Department of Commerce in 1916.

For reasons given in Mr. Norton's report, these quotations are lower than the true market value of the products sold in this country. In order to approximate the selling price to American consumers in 1914 these prices should be almost doubled because—

(1) The duty of 30 per cent ad valorem had not been paid.

(2) There are considerable possibilities of undervaluation.

(3) The charges for packing, freight, and insurance are not included.

(4) The selling expenses and the necessary profits of the agent in the United States must be added to these quotations.[1]

[1] See Artificial Dyestuffs Used in the United States, Special Agents Series No. 121, by Thomas H. Norton, Department of Commerce, pp. 23–25.

Attention is also called to the fact that in many cases the market prices for intermediates are lower than the average costs, as shown in column 1. This is accounted for by the fact that the market prices are fixed by companies which specialize to some extent in the production of intermediates and whose costs are therefore lower than the average cost for all companies because of the volume of output upon a restricted list of commodities.

It is possible that in some instances particular intermediates may be sold for a time at a loss by some companies, but for the most part the cases where average costs are higher than the prevailing market prices are to be accounted for by the high cost of intermediates to those companies who do not sell them but use them in the process of making dyes.

TABLE V-A.—*Comparison of costs with prewar and present prices—intermediates.*

[Dollars per pound.]

Product.	1 Average cost third quarter 1919.	2 Market price February, 1920.	3 German prices, 1914.
Intermediates:			
Acetanilid	0.4024	0.470	0.1548
Aniline	.2412	.310	.0807
Benzidine	1.2139	1.183	.3075
Benzoic acid	.....	.950	.1853
Betanaphthol	.3148	.460	.0720
Dianisidin	3.4966	9.750	.....
Dimethylanilin	.4829	.691	.1448
Dinitrobenzol	.2965	.290	.0631
H-acid	1.1993	1.525	.2302
Metaphenylenediamin	1.5165	1.040	.....
Nitrobenzol	.1047	.135	.0550
Ortho toluidin	.5491	.295	.0884
Paranitranilin	.8459	1.075	.1334
Paratoluidin	.5406	1.750	.1930
Phthalic anhydride	.....	.600	.2453

Column 2: These market prices were determined by averaging price quotations for particular products received from various companies. Column 3: The prices of intermediates were obtained from "Artificial Dyestuffs in the United States," Special Agents Series 21, by Thomas H. Norton, Department of Commerce. These prices were f. o. b. German ports and are probably about half the selling price in the United States.

TABLE V-B.

In Table V-B are shown the prices of certain dyes in various markets as compared with the cost in the United States for the third quarter of 1919. Attention is called especially to the reparation commission's prices in this table.

Under the terms of the treaty of peace (part 8, Annex VI, secs. 4 and 5, inclusive) and supplementing agreements between the reparation commission and the German cartel, the commission has the right of option upon a maximum of 50 per cent of all dyestuffs and chemical drugs in Germany or under German control as of August 15, 1919. Furthermore the commission has the right of option upon a maximum of 25 per cent of specified kinds of dyes and drugs produced in each six month period from the date of the coming into force of the treaty until January 1, 1925.

In August, 1919, however, while the ratification of the treaty was pending, a preliminary agreement was reached with the cartel in which several thousand tons of dyes were to be released to the Allies (1,500 tons to the United States) at a price agreed upon after some discussion. In general, the prices were determined by revising the

than our domestic prices and that if they were revised with the mark valued at 20 cents (the German offer to Dr. Herty), the quotations in the two countries would be surprisingly close together. In this connection it should be borne in mind that considerable additions should be made to the reparation prices because of duties, freight rates, etc., before the dyes can be laid down in this country. This does not mean, necessarily, that the American producers can successfully compete with the German producers in all phases of the dye industry because most of the quotations here are upon products now in quantity production in this country and do not show, for example, prices for vat and alizarin colors which are now being developed here. Other complicating factors which make it impossible to draw general conclusions from the price comparisons here given are the uncertain industrial future of Germany and the disturbed conditions of the rates of international exchange.

TABLE VI.—*Prices of a selected list of dyes.*

[Dollars per pound.]

No.	Product.	1 German prices 1914.	2 Market prices February, 1920.	3 Contract prices Dec. 1, 1919.	4 Reparation commission, mark at par.	Tariff Commission reports.[1] 5 1917	6 1918
48	Alizarin yellow G	0.140	0.833	0.560	1.0261	0.580	0.68
58	Alizarin yellow R	.420	1.307	.....	.....	.830	.91
536	Alkali blue B	.710	.....	5.350	3.4575	4.714	8.33
493	Auramine O	.370	2.500	2.000	2.7014	4.000	3.76
141	Azo yellow	.420	2.000	1.418	2.1610	.....	.....
337	Benzo blue 2B	.....	9.630	.....	1.6208	2.000	1.37
340	Benzo orange	.....	1.150	.....	1.2313	2.000	1.56
363	Benzo purpurine 4B	.230	1.788	.....	1.0805	2.820	2.46
112	Bordeaux B	.290	1.040	.....	.....	1.460	1.02
499	Brilliant green	.420	3.000	3.680	3.2411	.....	.....
342	Chrysamine G	.....	1.075	.....	1.3936	1.970	1.53
33	Chrysoidine	.340	.800	.756	1.9449	1.090	.77
304	Chrysophenine G	.560	2.500	.....	2.1610	12.640	5.71
307	Congo red	.....	1.300	.....	1.0805	2.470	2.01
169	Crocein scarlet 4B	.250	1.500	1.418	1.2636	.....	.....
516	Crystal violet	.690	4.500	.....	5.7800	.....	.....
275	Diamond black	.290	1.350	.....	1.3503	.....	.....
9	Direct yellow	.....	1.788	.....	.....	2.550	2.61
587	Eosine GGB	.570	.....	2.370	3.0252	8.580	7.81
161	Fast red A	.230	.983	.....	.....	1.190	1.03
137	Fast yellow G	.380	1.500	1.581	.9182	.....	.....
512	Fuchsine or magenta	.600	4.650	2.871	2.4635	9.100	7.72
626	Gallocyanine	.240	3.250	.....	.....	.....	5.12
874	Indigo, 20 per cent	.155	.750	.774	.8102	1.420	.88
173	Lithol red R	.190	.700	.....	.....	.....	2.38
495	Malachite green	.390	3.500	2.125	3.2414	6.280	5.60
89	Metachrome brown	.....	.800	.....	.....	.....	1.64
134	Metanil yellow	.310	1.583	.....	2.1610	.....	.....
659	Methylene blue 2B	.570	2.788	2.570	2.7015	3.090	2.80
515	Methyl violet 2B	.360	2.417	2.160	2.7015	3.840	2.78
7	Naphthol yellow G	.250	.....	.....	1.6205	.....	.....
217	Naphthylamine black 10B	.330	1.190	.....	.....	1.080	1.26
700	Nigrosine	.410	.617	.701	1.9449	.800	.63
145	Orange II	.220	.552	.....	1.1885	.980	.68
543	Patent blue A	.520	.....	.....	2.7011	.....	.....
573	Rhodamin B extra	.870	.....	.....	3.8900	.....	.....
181	Salicine black	.440	1.550	.....	.....	.....	.....
82	Scarlet 2R	.340	.804	.....	.....	1.150	.79
720	Sulphur black	.190	.238	.236	1.2422	.600	.37
	Sulphur blue	.150	.730	.....	.....	1.630	1.45
	Sulphur brown	.100	.483	.....	.....	.550	.48
	Sulphur yellow	.320	1.038	.....	.....	.990	1.09
23	Tartrazine	.280	1.700	.....	1.6205	.....	.....
559	Victoria blue B	.530	5.000	.....	4.5380	.....	.....

[1] Census of Dyes and Coal Tar Chemicals, 1917 and 1918.

TABLE VII.

Table VII is like Table VI, except that the prices are expressed in percentages with the prewar price of dyes in the United States of German manufacture as the base (100 per cent). No new factors are brought out by this method of presentation, but it shows clearly the relation among the various price quotations. The prices in 1917 and 1918 of American made dyes were several hundred per cent higher than before the war, but in recent periods the decline from this high level is marked.

The reparation commission's prices are in general not far different from the present domestic prices and for the particular products here quoted the American producers probably have little to fear from foreign competition.

TABLE VII.—*Relative prices of a selected list of dyes.*

[Base (100 per cent) is the German prices f. o. b. warehouse in United States in 1914.]

No.	Product.	1 German prices 1914.	2 Market prices February, 1920.	3 Contract prices Dec. 1, 1919.	4 Reparation commission, mark at par.	Tariff Commission reports.[1] 5 1917	6 1918
[illegible]	Alizarin yellow G	100	595	400	733	421	486
[illegible]	Alizarin yellow R	100	311	.....	.....	198	217
[illegible]	Alkali blue B	100	.....	754	487	664	1,173
[illegible]	Auramine O	100	675	557	730	1,081	1,016
[illegible]	Azo yellow	100	476	338	515	.....	.....
[illegible]	Benzo blue 2B	.....	.....	.....	.....	.....	.....
[illegible]	Benzo orange	.....	.....	.....	.....	.....	.....
[illegible]	Benzo purpurine 4B	100	777	.....	470	1,226	1,069
112	Bordeaux B	100	359	.....	.....	503	352
[illegible]	Brilliant green	100	714	876	772	.....	.....
[illegible]	Chrysamine G	.....	.....	.....	.....	.....	.....
[illegible]	Chrysoidine	100	235	222	572	320	226
304	Chrysophenine G	100	446	.....	385	2,257	1,019
[illegible]	Congo red	.....	.....	.....	.....	.....	.....
[illegible]	Crocein scarlet 4B	100	600	567	505	.....	.....
[illegible]	Crystal violet	100	652	.....	838	.....	.....
[illegible]	Diamond black	100	466	.....	466	.....	.....
9	Direct yellow	.....	.....	.....	.....	.....	.....
[illegible]	Eosine GG B	100	.....	348	445	1,261	1,148
164	Fast red A	.....	427	.....	.....	517	447
137	Fast yellow G	100	395	608	353	.....	.....
512	Fuchsine or magenta	100	775	478	410	1,516	1,286
[illegible]	Gallocyamine	100	1,354	.....	.....	.....	2,133
[illegible]	Indigo, 20 per cent	100	484	499	522	916	567
173	Lithol red R	100	368	.....	.....	.....	1,322
[illegible]	Malachite green	100	898	545	831	1,610	1,435
[illegible]	Metachrome brown	.....	.....	.....	.....	.....	.....
134	Metanil yellow	100	511	146	.....	.....	.....
[illegible]	Methylene blue 2B	100	489	451	474	542	491
[illegible]	Methyl violet 2B	100	671	600	750	1,066	772
7	Naphthol yellow G	100	.....	.....	648	.....	.....
217	Naphthylamine black 10B	100	361	.....	.....	327	382
700	Nigrosine	100	150	171	474	195	154
145	Orange II	100	251	.....	540	445	309
[illegible]	Patent blue A	100	.....	.....	519	.....	.....
[illegible]	Rhodamin R extra	100	.....	.....	447	.....	.....
181	Safranine black	100	352	.....	.....	.....	368
82	Scarlet 2R	100	236	.....	.....	338	232
720	Sulphur black	100	125	124	654	315	194
	Sulphur blue	100	487	.....	.....	1,086	966
	Sulphur brown	100	483	.....	.....	550	480
	Sulphur yellow	100	324	.....	.....	413	454
23	Tartrazine	100	607	.....	579	.....	.....
559	Victoria blue B	100	943	.....	856	.....	.....

[1] Census of Dyes and Coal Tar Chemicals, 1917 and 1918.

SUMMARY.

Care should be exercised in drawing conclusions from the cost data here submitted.

In the first place the cost records were not kept upon a uniform basis and they reflect the true cost situation with varying degrees of accuracy depending upon the peculiarities of the systems in use among the various companies.

Mistaken conclusions growing out of inadequate cost records may not be so serious, however, as those caused by chaotic productive conditions. Unless a more detailed study of the variations in cost among the several plants is presented than can be set forth in a published report, great differences of opinion may arise as to the future of the dye industry in this country from the study of average cost figures alone.

In Table I, for example, the average costs of such well-established products as sulphur black, nigrosine and direct black are found to be increasing in recent periods; and from this one might conclude that lower costs are not to be expected from quantity production, whereas, as a matter of fact, the higher average is due to very high costs for one or two companies whose yields were low on account of various accidental circumstances. Furthermore, in Table II–A the costs for different producers are seen to vary by a large percentage from the average cost for all companies. In almost every case these variations are explainable by some accidental circumstance, which in the long run probably will be eliminated but which now affects the whole trend of cost to such an extent that conclusions based upon average figures are likely to be erroneous.

Another minor source of error is shown in Table IV, in which the charges for special items, such as depreciation, interest, and administrative expenses, are given. The charges for these items on the books of the reporting companies were accepted as the facts in the case and no attempt has been made in this report to introduce uniformity with respect to them. The purpose in showing them in a separate table is to indicate their influence upon the total unit cost for the industry as a whole.

In Tables V–A and V–B are compared domestic costs for the third quarter of 1919, with price quotations for various times and places. Some of the important points brought out by this table are, first, that present costs of American made product are from two to five times higher than the prewar price of dyes and intermediates laid down in this country from Germany; and, second, that the reparation prices, with the mark valued at par (practically the price at which the German syndicate offered dyes through Dr. Herty), are in most cases a little higher than the price of the same dyes in this country at the present time.

It should not be concluded from this latter statement, however, that the American producers can compete with foreign manufacturers in all parts of the industry, because in some classes of products such as vat and alizarin colors, which are not shown in these tables, but which are of fundamental importance to a well-rounded industry, the foreign producers yet have a competitive advantage born of long practice in complicated productive processes.

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UNITED STATES TARIFF COMMISSION
WASHINGTON

Tariff Information Series—No. 16

REFINED SUGAR

Costs, Prices, and Profits

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INTRODUCTION.

Tariff Information Series No. 9, "Costs of Production in the Sugar ndustry," was published by the Commission early in 1919. This eport made a study of costs of production of raw sugar in Louisiana, Hawaii, Porto Rico, and Cuba, and of beet sugar in the Continental Jnited States. The specific items of costs were discussed, the rela- ion between "marginal" cost of production and price, the effect of he war upon costs and prices, and the extent to which the industry vas dependent upon the tariff.

The present report will treat the refining of sugar on a similar plan. It will also describe in some detail the activities of the United States Government through its several agencies, the Food Adminis- ration, the International Sugar Committee, and the Sugar Equaliza- ion Board, in regulating the price and distribution of sugar. These ctivities were an interesting innovation in governmental inter- vention and control in industry, and as the determination of price was based largely upon data collected by the Tariff Commission, it is fitting that some allusion to these activities should appear in this report.

For reasons that will be explained later, the refining of sugar is an industry which has manifested a strong tendency to combination. The "sugar trust" was one of the earliest to be formed. The effects of the several attempts at combination upon prices and profits will therefore be one of the items discussed in this report.

In this connection also, because of the alleged connection between the tariff and the formation of trusts, it will be pertinent to inquire to what extent, if any, the tariff has been an aid to combination in the sugar refining industry, and to what extent changes in rates of duty have affected prices and profits.

The two reports are therefore in a way complementary to one another and, when read together, make a fairly complete study in costs and prices and the relation between them in one of the most important industries in the United States during the period of the Great War.

The Commission had the services of Philip G. Wright, of the Com- mission's staff, in the preparation of this report.

be estimated from the quantity of raw sugar received—approximately 4,500,000 tons per annum.

Materials, equipment, machinery.—Aside from the raw sugar consumed and an abundance of pure water, the materials chiefly employed in the industry are lime for clarifying, canvas for the bag filters, animal charcoal for the bone-char filters, and bags, barrels, or other containers for marketing the product.

Process of refining.—The impurities to be removed in refining consist of molasses, adhering to the crystals, and certain organic and inorganic particles which have not been removed by the previous process. The raw sugar is first washed or "affined" with concentrated sirup in large vats, or sprayed with water, steam, saturated sugar solution, or paraffin oil in centrifugal machines. It is next dissolved or "melted" in water and subjected to a clarifying process with lime, similar to that employed in the manufacture of raw sugar. Next comes filtration, first through bag and then through bone-char filters, after which it is evaporated, crystallized, and separated from the surrounding liquid in centrifugal machines, much as in the manufacture of raw sugar. The greater part of the sugar is then simply dried, packed, and marketed as granulated sugar. A portion, however, is subjected to further processes in order to prepare it for marketing in other forms, as powdered sugar, candis sugar, dominoes, etc.

As the process of refining is simply a removal of impurities from the raw sugar, there is necessarily a considerable loss of weight. It requires about 107 pounds of raw sugar, polarizing at 96°, to produce 100 pounds of refined granulated. Some of the loss, however, is recovered in the sirup which is manufactured as a by-product of the refinery.

Scale of production.—The refining of sugar calls for large investment in plant and machinery, and lends itself to the economies of large-scale production to an even greater extent than does the manufacture of raw sugar. The cost of transporting the cane, being high in comparison with its value, sets a limit to the size of the factory which can be profitably employed in the manufacture of raw sugar. Beyond this limit the economy of large-scale production can only take the form of consolidation in management, one management operating several factories. The same reasoning applies to beet sugar also. No such limit, however, is set to the size of establishments engaged in the refining of sugar. The cost of transporting raw sugar, especially when water transportation may be employed, is low compared with the value. A single refinery may draw its supplies virtually from the whole world. One management, therefore, may operate either a single colossal refinery, limited in size only by the supply of raw material and the demand for its product, or several refineries in

different localities, according as it may secure the greater economy in marketing its products.

Consolidation.—The condition outlined in the last paragraph is precisely that affording the greatest promise of profit from consolidation—profit to be realized (1) from the economy of large scale production, and (2) from control of output through monopoly. The economy is for the public interest, the monopoly may well not be. Both, however, are for the interest of the industry, and the temptation to avail itself of the opportunity is strong. In the absence of positive legal enactments to the contrary it may be taken for granted that monopoly will be attempted. The industry with which we are dealing was, in fact, one of the earliest to make the attempt. The "Sugar Trust," organized in 1887, was a "trust" in the legal sense as applied to its form of organization, as well as in the derived sense of a monopoly. The consolidation having come under the condemnation of the courts, the management next attempted to accomplish the same purpose through a different form of organization. To this end a single new corporation, the American Sugar Refining Co., was chartered, representing the same interests as those concerned in the former "trust." Although, as stated, the conditions were such as to invite attempts at monopoly, the monopoly has never been able to maintain control of supply for any considerable period of time. There has always been not only potential competition, but on several occasions active competition; in 1889 with Spreckels, and in 1897 with the Arbuckles. At present there are a dozen or more competing refineries. The American still furnishes from 30 to 40 per cent of the output, but can not be said to occupy a monopoly position in control of supply and prices. Later in this report a statistical study will be made with a view to determining what was, in fact, the effect of the monopoly on prices and profits.

Geographical distribution.—The supply of raw sugar for the refineries comes from Louisiana, Cuba, Porto Rico, the Hawaiian, Philippine, and Virgin Islands; and, to a small extent, from other sources. As all of these sources of supply, except Louisiana, involve ocean transportation, the location of refineries is thereby determined at points accessible to navigation. The refineries are found along the Atlantic and Pacific coasts, and in Louisiana and Texas. As, in this country, there are no separate establishments for refining beet sugar, the distribution of beet-sugar refineries may be said to be identical with that of beet-sugar factories. The industry centers in California, Colorado, Utah, Idaho, and Michigan.

Domestic output and consumption.—The total consumption in 1919 in terms of refined sugar was 4,555,792 short tons, which on a basis of 106,700,000 population makes a per capita consumption of 85.4 pounds. This exceeded the consumption of 1918 by 640,813 tons or

12 pounds per capita. Of the above, about 976,923 tons was beet sugar. The consumption in 1919 exceeded all previous records.[a]

Exports.—For the purpose of export, sugar refined from imported raws is always used. By taking advantage of the drawback, refiners can obtain such raws at a price of about 1 cent per pound cheaper than raws of domestic production and hence the latter are not refined for export. In normal times the export trade is not large, amounting to only about 1 per cent of the receipts, but during the war it attained a position of considerable importance. For the three-year period 1915–1917, about 12 per cent of the total annual receipts were exported.[2] Even full-duty sugar which, in the years immediately preceding the war, had virtually disappeared from our list of imports, during the war was imported for the purpose of refining for export in considerable quantities. The drawback puts such sugars practically on a parity with Cubas.

Much of the sugar listed as exported in 1918 and 1919 was not, strictly speaking, an export. It was sugar purchased by the Royal Commission in Cuba and refined in the United States. In 1919 sugar so purchased amounted to 581,840 tons.

Imports of refined sugar are insignificant. The efficiency of American refiners and the net protection on refining (about 0.1 of a cent per pound) are sufficient to preclude foreign competition.

FOREIGN PRODUCTION.

The United Kingdom.—Several attempts have been made to introduce the production of beet sugar in the United Kingdom. These efforts have hitherto met with little success. As a result of the war, however, the matter is now being taken up with energy by the British Sugar Beet Growers' Society. Land has been secured, and is now in condition to begin planting. It is expected that a factory will be ready to begin operations before the autumn of 1921. The prospect is more favorable than that of previous attempts because of the preference of £6 4s. 5⅓d. per ton on home-grown sugar over foreign imported sugar.[b]

[a] The figures in this paragraph are Willett and Gray's estimate reduced to short tons. See Weekly Statistical Sugar Trade Journal, Jan. 15, 1920, pp. 18–19.

[2] *Table 1.*—The following table shows the increase in exports during the war and also the increase in drawback payments:

Year ending June 30—	Exports (million pounds).	Drawback paid (thousand dollars).	Year ending June 30—	Exports (million pounds).	Drawback paid (thousand dollars).
1912	54	920	1916	1,324	13,490
1913	57	873	1917	1,490	15,192
1914	29	391	1918	934	9,413
1915	492	5,051			

[b] The Colonial preference on the same grade of sugar is £4 5s 0⅔d per long ton. Hence the preference on domestic beet sugar exceeds the colonial preference by £1 18s 10⅔d. See International Sugar Journal, October, 1919, p. 478.

Moreover, the Government is to subscribe £250,000 of the capital, provided a like sum is secured by public subscription and is to guarantee 5 per cent dividends on the private stock for 10 years. The refining of cane sugar, however, is already an important industry. Before the war about half the domestic consumption was refined in British refineries, and the other half was imported already refined. Taking 1913 as typical, 1,172,321 tons[3] of raw sugar were imported, which after deducting the comparatively small portion consumed as brown sugar, Demerara sugar, etc., were refined in British refineries, and 1,033,250 tons were imported already refined. Of the above importations, 708,830 tons of raw sugar and 743,139 tons of refined sugar were imported from Germany and Austria-Hungary.

From these figures it will be seen that Great Britain was dependent for nearly two-thirds of her supply of sugar upon the Central Powers. The deficit from this source caused by the war was in part made good by increased importations of cane sugar, especially from Cuba and other American sources, and in part it was not made good at all. The importation of raws in 1917 was 1,364,203 tons,[4] of which 57.4 per cent was from Cuba; and of refined, 189,805 tons, of which 22.2 per cent was from the United States. It will be seen that the total supply was over 650,000 tons, or nearly 30 per cent, less in 1917 than in 1913. As one means of meeting the enormous war liabilities, the Government has imposed heavy import duties, graded with reference to the centrifugal test, upon sugar, and in order to become less dependent in the future upon foreign sources of supply, has granted preferential rates one-sixth less than the full duty upon all sugars imported from British possessions. For 96° centrifugals the full duty is 22s. 4.5d. per hundredweight (4.8 cents per pound). The preferential rate is therefore 18s. 7.75d. per hundredweight (4 cents per pound).

The Central Powers.—Germany, before the war, was the largest beet sugar producer in the world. Part of the output was refined and part exported raw. In 1913–14 the total production was 2,993,704 tons. In 1913 the exports of raw sugar were 581,060 tons and of refined sugar 649,603 tons. The total production for 1918–19 was 1,581,298 tons,[5] less than 53 per cent of the prewar production.

Austria-Hungary, in 1913–14, was second to Germany in the production of beet sugar—1,854,169 tons. The preceding year the output was even larger—2,093,796 tons. Her exports in 1913 were 206,627 tons raw and 977,756 tons refined. With the war Austria-Hungary, as a single nation, ceased to exist. Willett & Gray estimates the production of "Czecho-Slovakia, etc.," in 1918–19, as 784,000 tons.

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[3] All foreign data for 1913–14 are from "The Cane Sugar Industry," Department of Commerce, Miscellaneous Series, No. 53.

[4] British data for 1917, from the International Sugar Journal, February, 1919, p. 99 (reduced to short tons).

[5] Foreign production data for 1918–19, Willett & Gray's estimate (reduced to short tons).

Russia, in 1913–14, was third on the list of beet-sugar producing countries—1,681,247 tons. Like Austria-Hungary, it is now split into several States, the production of which for 1918–19 was 784,000 tons.

France also suffered heavily. In 1913–14 her production was 790,790 tons; in 1918-19, 123,307 tons. The beet sugar region in France was, in the main, the region occupied by the German armies. Of 208 factories in operation in 1914, only 65 remained in 1917. It was at first thought that the tearing up of the soil by shell fire would render it infertile for many years. This conclusion is now questioned, at least for some crops.

General statement as to foreign production.—Without discussing the situation in other sugar-producing countries in detail, enough has been written to indicate some of the main features in the world sugar situation produced by the war. At its outbreak the world's sugar supply was made up of beet and cane sugar in not far from equal proportions—54 per cent cane and 46 per cent beet. The great center of beet sugar production was Europe, especially those parts of Europe directly involved in the war. Hence, as a result of the war the production of beet sugar was reduced about 4½ million tons. To make good this enormous shortage in the world's sugar supply, cane sugar production, especially in Cuba, has been greatly stimulated, the present output being some 2¼ million tons in excess of the pre-war output. Even this increase, however, is insufficient to make good the loss, and the world is still over 2 million tons short of its pre-war production. From a position of approximate equality the beet-sugar production is now only about 26½ per cent of the world production, while cane sugar is 73½ per cent. As the refining of cane sugar is more universally carried on as a separate industry than the refining of beet sugar, such a situation tends to increase the business of the refineries. Moreover, cane sugar is a tropical product, while beet sugar is a product of the temperate zone. The increased emphasis upon cane sugar therefore tends to increase trade with the tropics. More important to the average consumer is the effect of the world shortage upon his accustomed supply and the price he pays for it. Prices have risen greatly, and would doubtless have risen more had it not been the general policy of the several Governments to intervene and modify the normal operation of the law of demand and supply by regulating price and distribution.

TARIFF HISTORY.

In the United States refined sugar has always been subject to a higher duty than raw sugar, thus affording it a net protection. In early acts various terms were used to designate the higher grade sugars, such as white, clayed, or powdered sugar, and refined, loaf,

lump, crushed, or pulverized, and the trade name of the sugar determined the rate of duty. An attempt at a more scientific classification was made in the act of August 5, 1861, by the introduction of the Dutch standard, in accordance with which the different grades were judged by color, the darker the color the lower the grade.[6] The Dutch standard continued to be used until the act of October 3, 1913. In the act of March 3, 1883, however, the polariscopic test was combined with the Dutch standard. Sugars not above No. 13 Dutch standard, and not above 75° by the polariscope, paid a duty of 1.4 cents per pound, with an additional duty of 0.04 of a cent per pound for each polariscopic degree above 75. By the act of October 1, 1890, sugar below No. 16 Dutch standard was placed on the free list with a bounty in lieu of the former protection. Sugar above No. 16 Dutch standard was granted a protective duty of $\frac{1}{2}$ cent per pound. In the act of August 27, 1894, a uniform ad valorem duty of 40 per cent was imposed upon all sugars, to which was added on all sugars above No. 16 Dutch standard a specific duty of $\frac{1}{8}$ of a cent per pound. In the acts of July 24, 1897, and July 4, 1909, the combined Dutch standard-polariscopic test was restored. Sugars not above No. 16 Dutch standard and not above 75° by the polariscope paid a specific duty of 0.95 of a cent per pound, with an addition of 0.035 of a cent per pound for each additional polariscopic degree. If, however, the sugar was refined or above No. 16 Dutch standard, a specific duty of 1.95 cents per pound in the act of 1897 and 1.9 cents per pound in the act of 1909 was imposed irrespective of the polariscopic test. By the act of October 3, 1913, the Dutch standard test was abandoned. All sugars testing not above 75° by the polariscope paid a duty of 0.71 of a cent per pound with an additional duty of 0.026 of a cent per pound for each additional polariscopic degree.[7] In this act refined sugar is given no specific mention and receives no higher rate of duty as such, but only as it shows a higher polarization. In the two preceding acts the wording is such as to imply that a raw sugar might be above No. 16 Dutch standard and a refined sugar below. An objection to the Dutch standard test was that a sugar of high sucrose content might be artificially colored so as to bring it into a lower class, and hence pay a lower rate of duty than other sugars of equal sucrose content. The coloring matter might be of such a nature as to be easily removed after importation, and hence a high-grade sugar would be admitted at a rate too low for its grade.

One of the most important acts in connection with the tariff history of sugar was the Cuban reciprocity act of December 17, 1903,

[6] The origin of the term "Dutch standard" lies in the fact that the graded samples used for making the color comparison were prepared by two Dutch firms and generally accepted as standard by merchants and custom-house officers throughout the world.

[7] The act of 1913 as originally passed provided that all sugar should be admitted free of duty [illegible]. This proviso was repealed by special act of April 27, 1916.

in accordance with which all imports from Cuba, including s were given a preferential rate of 20 per cent discount from th duty. This preference was sufficient, after a period of five c years, to cause imports of sugar from Java, Germany, and some sources of supply, which previously had been considerable, al to disappear. Cuba is now, under normal conditions, the only fo country from which imports of appreciable magnitude are rece

Another matter deserving mention in connection with the history of sugar is the treatment accorded the Philippine Isl By the act of March 8, 1902, all imports from the Philippines (in ing sugar) were given a rate equal to three-fourths of the full d By the act of August 5, 1909, sugar not to exceed 300,000 gross was admitted free, the excess paying the three-fourth rate. As i year since 1909 have the imports of sugar from the Philippines rea 300,000 tons, the act virtually amounted to placing Philippine s on the free list. By the act of October 3, 1913, even the 300,(ton limit was removed, and Philippine sugar to any amount admitted free.

NET PROTECTION—REFINERS' DIFFERENTIAL.

Operation of a protective duty.—The duty paid by an importer a commodity which is produced both at home and abroad *and is fact continuously imported in any considerable quantities*, tends maintain the American price at a level higher than the foreign pr by an amount at least equal to the duty. The American manuf turer who may be at some disadvantage with respect to the co of raw materials, labor, or other items, is thus "protected" (subje to the qualifications given in the next paragraph) and enabled compete in the American market with the foreign producer.

Effect of a duty on raw materials upon the protection of the finish product.—If, however, the raw material must be imported and if also is subject to a duty, this duty may so raise its price above th price which the foreign manufacturer pays as to neutralize the pr tection afforded by the duty on the finished product, or even plac the American producer at a disadvantage. When, therefore, ther is a duty upon raw materials, a duty, of which the aim is protection granted to a finished product may be regarded as made up of tw parts: (1) A compensatory duty to cover the disadvantage caused by the Government itself in imposing a duty on raw materials; (2) net protection to cover all other disadvantages.

Net protection, then, is the difference between the duty which the importer must pay on a unit of the finished product and that part of the cost of producing a unit to which the American manufacturer is subjected because of the duty on raw materials. This cost can not be determined simply by the rate of duty on the raw material.

REFINED SUGAR.

Two factors need to be considered: (1) The duty on a raw material may not cause any increased cost whatever. If it is produced in sufficient quantity and sold in the United States as cheaply as in any country, none of it will be imported. The duty, however high, is purely nominal. The full amount of the duty on the finished product is net protection. So long as the duty is prohibitive the disadvantage of the American manufacturer in the price of his raw material may be anywhere between zero and the amount of the duty. When, however, the raw material is actually imported in considerable quantities, it may be assumed without serious error that the price to the American manufacturer (after allowing for freight, commission, and other charges) is higher than the foreign price by substantially the amount of the duty. This is the case with sugar. (2) The number of units of the raw material required for one unit of the finished product must be considered. In the case of sugar it takes about 1.07 pounds of 96° centrifugal sugar to produce 1 pound of refined granulated. If the duty on 96° centrifugals is 1.0048 cents per pound, then that part of the cost of producing a pound of granulated which is caused by the duty on raw material is 1.0751 cents. Hence, the duty on granulated must be at least 1.0751 cents per pound in order to place the American refiner on a parity with his foreign competitor. Only the excess of the actual rate above 1.0751 cents per pound is net protection. Indeed, the cost is increased slightly more than 1.0751 cents. On every pound of refined sugar produced, the refiner is compelled to tie up 1.0751 cents in working capital more than would be required if there were no duty on raw sugar. Hence, the interest on 1.0751 cents for the average period of time which elapses between the payment of duty for the imported raws and the receipt of payment for the sale of the refined must be allowed as part of the compensatory duty. This period of time may be estimated as one month. The interest at 6 per cent of 1.0751 cents for one month is 0.0054 of a cent. Hence, the compensatory duty on refined sugar is 1.0805 cents per pound.

The above principles are applied in the following table to the problem of determining the net protection on refined sugar in the successive tariff acts since 1883. Specific rates are in cents per pound. Raw sugar is assumed to be 96° centrifugal test, and refined sugar, 100°. Inasmuch as Cuba does not produce refined sugar, in determining the net protection after 1903 (the year of the Cuban reciprocity treaty), the Cuban duty is assumed as the rate of duty on raws and the full duty as the rate of duty on refined. The refiner was put under no further disadvantage than that due to paying the Cuban duty.[a] On the other hand, the importer of refined sugar,

[a] This is not strictly true for all months of the year for several years after 1903. During those months in which no Cuban sugars were on the market, the refiner was obliged to pay full duty on such raws as he might purchase from foreign countries.

competing with the American refiner, was obliged to pay full duty because no refined sugar could be obtained from Cuba.

TABLE 2.—*Rates of duty on raws, reduced to duty costs per pound refined, rates of duty on refined, and net protection, under successive tariff acts from 1883 to 1913. All specific rates are expressed in terms of cents per pound.*

Act of—	Rate of duty 96° centrifugals.	Cost of duty per pound of refined sugar.	Cost, including 1 month's interest at 6 per cent.	Rate of duty on refined sugar.	Net protection.
Mar. 3, 1883	2.24	2.3968	2.4068	3.5	1.0912
Oct. 1, 1890	0	0.0	0.0	0.5	.5000
Aug. 27, 1894	40 per cent ad val.	.8988	.9033	a 1.325 (40 per cent and 0.125)	.4217
July 24, 1897	1.6850 (full duty)	1.8029	1.8119	1.95 (full duty)	.1381
Do	1.3480 (Cuban duty)	1.4424	1.4496	do	.5004
Aug. 5, 1909	do	1.4424	1.4496	1.90 (full duty)	.4504
Oct. 3, 1913	1.0048 (Cuban duty)	1.0751	1.0805	1.36 (full duty)	.2795

a Specific equivalent of ad valorem duty, based on price of 2.1 cents per pound for raws and 3 cents per pound for refined.

Refiners' differential.—While the actual net protection enjoyed by the refiners has been the amounts shown in the last column of the above table, a method came into general use in connection with the acts of 1897 and 1909 for computing what was known as the "refiners' differential," supposed to represent the net protection to the refiners. Under the provisions of both acts (see page 13) duty on a hypothetical raw sugar testing 100° by the polariscope would have been 1.825 cents per pound ($.95+.035\times25$). If this amount is subtracted from the duty on refined sugar (1.95 cents per pound, 1897; 1.90 cents per pound, 1909) the "refiners' differentials" of 0.125 and 0.075 cents per pound, respectively, will be obtained. These results do not differ greatly from those obtained by the method of the above table when full duty for both raw and refined is used in the computation, 0.1381 in 1897 and 0.0881 in 1909. The refiners, however, in reality enjoyed a higher degree of protection than this after the passage of the Cuban reciprocity treaty, because, as explained above, the refiners received the benefit of this concession in their importation of raws, while potential competitors in the form of importers of refined sugar could not obtain such sugars from Cuba and hence would have been obliged to pay full duty.

II. PREWAR PRICES AND PROFITS.

Prices 1880 to 1919.—The following table (Table 3) shows the prices in cents per pound—average New York quotations—of 96° centrifugals and refined granulated, together with the so-called refiners' margin, which is the difference between them:

TABLE 3.—*New York prices 96° centrifugals, and refined granulated; also the refiners' margins, 1880 to 1918. Prices and margins in cents per pound.*

Year.	96° centrifugals.	Refined.	Margin.	Year.	96° centrifugals.	Refined.	Margin.
1880	8.206	9.602	1.396	1900	4.566	5.320	0.754
1881	8.251	9.667	1.416	1901	4.047	5.050	1.003
1882	7.797	9.234	1.437	1902	3.542	4.455	.913
1883	7.423	8.506	1.083	1903	3.720	4.638	.918
1884	5.857	6.780	.923	1904	3.974	4.772	.798
1885	5.729	6.441	.712	1905	4.278	5.256	.978
1886	5.336	6.117	.781	1906	3.686	4.515	.829
1887	5.245	6.013	.768	1907	3.756	4.649	.893
1888	5.749	7.007	1.258	1908	4.073	4.957	.884
1889	6.433	7.640	1.207	1909	4.007	4.765	.758
1890	5.445	6.171	.726	1910	4.188	4.972	.784
1891	3.863	4.641	.778	1911	4.453	5.345	.892
1892	3.311	4.346	1.035	1912	4.162	5.041	.879
1893	3.689	4.842	1.153	1913	3.506	4.278	.772
1894	3.240	4.120	.880	1914	3.814	4.683	.869
1895	3.270	4.152	.882	1915	4.642	5.559	.917
1896	3.624	4.532	.908	1916	5.786	6.862	1.076
1897	3.557	4.503	.946	1917	6.228	7.663	1.435
1898	4.235	4.965	.730	1918	6.447	7.834	1.387
1899	4.419	4.919	.500				

These figures are plotted in the diagram (fig. 1) in which form their significance can be best studied. The line AA′ shows the course of the prices year by year of refined granulated; the line BB′ the course of prices of 96° centrifugals, New York quotations; and the line CC′ the course of foreign prices f. o. b. foreign port.[9] The line DD′ shows the refiners' margin from year to year, i. e., the difference between the price of refined granulated and 96° centrifugals. It is for each year the distance between the lines AA′ and BB′ plotted from the base line OX, i. e., for example, the distance OD is equal to the distance OA–OB.[10]

Price fluctuations.—It will be seen at a glance that the price fluctuations from year to year have been large, but that the price movements of raw and refined have approximately paralleled one another, so that the fluctuations in the refiners' margin, while considerable, have been much less violent.

Trends.—Further study will show that, with a violent reaction in the late eighties, there was a general downward trend of prices (both of raw and refined) from 1880 to 1894, a slow upward trend from that date to 1913, and a sharp upward trend from 1913 to 1919. The refiners' margin shows a general downward trend from 1880 to 1913, and an upward trend from that date to 1919. The trends referred

[9] The data for foreign prices were derived from the United States Statistical Abstract, except for the year 1919. For this year the price fixed by the Sugar Equalization Board for Cuban sugar was used. The data for foreign prices are for fiscal years ending June 30. All of the other data are for calendar years. In constructing the diagram, therefore, the salient points in the line CC′ were all moved six months to the left. For example, the foreign price for 1914 is placed midway between the vertical lines from 1913 and 1914.

[10] The data for refined granulated, for 96° centrifugals, and refiners' margin as given in Table 3 are all average New York quotations. The same data are also used in constructing the diagram (fig. 1) to and including the year 1913. Beginning with 1914, however, the data used in constructing the diagram are derived from schedules submitted by refiners to the Commission. (See Table 6, average by poundage.) The two sets of data differ slightly but not enough to affect in any way the conclusions.

to are shown by the dotted straight lines GG′, HH′, II′ (refined sugar); KK′, LL′, MM′ (96° centrifugals); NN′, PP′ (refiners' margin).

These lines were "fitted" to the "curves" by familiar statistical methods.[11]

Profits.—From the margin (shown in the diagram by the line DD′) the refiner, after deducting all refining and marketing costs, makes his profit. The sum of these costs is shown by the line EE′. Hence, the vertical distances between the lines DD′ and EE′ (the shaded area in the diagram) represent the profits from year to year. The portion of this area for the years following 1913, was plotted from data obtained direct from the refineries by the Commission. For the years preceding 1914, the refiners' margin was obtained from printed lists of New York quotations of prices of 96° centrifugals and refined granulated, believed to be reliable. The costs, however (shown by that portion of the line EE′ extending from 1880 to 1913), are only a rough estimate, no data being available. The estimate, however, is believed to be sufficiently close to warrant the conclusions as to the effects of combinations and tariff acts upon profits—discussed in the following paragraphs.[12]

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[11] The method of moments was employed. The equations of the trends, taking the origin at a date midway between the extremities, were: GG′, $y=-0.377x+6.74$; HH′, $y=0.018x+4.75$; II′, $y=0.884x+6.709$. KK′, $y=-0.35x+5.7$; LL′, $y=0.018x+3.91$; MM′, $y=0.684x+5.488$; NN′, $y=-0.0101x+0.9269$; PP′, $y=0.1994x+1.220$.

[12] The mathematical process employed in obtaining the cost line EE′ was as follows: The costs, which must be deducted from the refiners' margin in order to obtain the profits, are made up of the following items: (1) Cost due to loss of weight in raws in the process of refining (approximately 7 per cent of price of raws): (2) refining and marketing costs diminished by receipts from by-products. Item 2 was found for the year 1914 to be 0.444 of a cent per pound of refined sugar. For each preceding year it was next assumed that the costs included in item 2 would be proportional to the index number of wholesale prices for that year as compared with the index number for 1914. Inasmuch, however, as the cost of refining sugar is greatly influenced by the volume of business done, the normal production for each year was next determined by "fitting" a straight line to a graph on which were plotted the actual quantities of sugar refined in each year. Then, if the actual meltings exceeded the normal the cost for that year was diminished by the ratio of the normal to the actual meltings. If the actual meltings were less than normal the cost was increased by the same ratio. This process obviously exaggerated the effect upon cost of the volume of business. The true cost would probably lie somewhere between the cost as thus modified for volume of business and the cost unmodified. But it was found that all of the conclusions given in the text would be the same whether the modifications were made or not. Therefore, it would follow that the same conclusions would be reached with the true costs (could they have been ascertained), since they lie somewhere between these limits.

Item (1) was computed by multiplying the prices of 96° centrifugals, New York quotations, by 7 per cent. It is believed that 7 per cent is a liberal allowance for the cost due to loss of weight in refining. For the years for which data were available this percentage was: 1914, 5.3 per cent; 1915, 6.1 per cent; 1916, 6.3 per cent; 1917, 7.2 per cent; 1918, 7.4 per cent; 1919, 6.7 per cent; the average being 6.5 per cent.

Finally the costs in items (1) and (2) were added and from the sums the line EE′ was constructed.

The average of all the costs thus ascertained was found to be 0.724 of a cent. The cost usually assumed and used by Dr. Taussig in making a similar study in his "Some Aspects of the Tariff Question," p. 105, is ¾, or 0.625 of a cent. For the years immediately following 1880 this last figure is obviously too small. The cost from loss of weight of raws, because of the high price of raws in these years, nearly equals this amount alone, to say nothing of the costs of refining and marketing. If we omit the earlier years in averaging the costs as ascertained above for the years 1891–1914, the result is found to be 0.646 of a cent. As stated above, 7 per cent is probably slightly too large an allowance for loss of weight in raws. If 6.5 per cent (the percentage actually obtained for the years 1914–1919) be used instead of 7 per cent, the average becomes 0.627, a figure very close to that assumed by Dr. Taussig. The weakest point in the above method of computing costs lies in the assumption that refining and marketing costs, less receipts for by-products, are

Effects of combination and competition on profits.—The diagram is crossed vertically by lines corresponding with the dates at which events having a bearing on the history of the industry occurred. A study of these lines in connection with profits brings out the following facts: From 1884 to 1887 profits were very low; part of the time, apparently nil. This was just the condition to stimulate combination when taken in connection with the hope of monopoly profit and the economies of large scale production. The combination was effected—the well-known "Sugar Trust"—in 1887. Immediately profits increased and continued large until 1889. In this year a formidable competitor appeared in the person of Claus Spreckels. Mr. Spreckels had previously established a monopoly on the Pacific coast in which he secured the advantages not only of a seller's but also of a buyer's monopoly. He was in a position, because of the possibility of importing sugar from Cuba, to compel the Hawaiians to sell their raws to him slightly below New York quotations and, as the only alternative open to Pacific coast purchasers who did not choose to buy refined sugar from him was to import it from the East, he could exact from them a price higher than New York quotations by freight charges across the continent. This enviable situation induced the "Trust" to set up a rival refinery on the Pacific coast. Spreckels responded by setting up a refinery in Philadelphia and for two years competition was active. The diagram shows profits as negative in 1890 and small in 1891. In 1892 Spreckels was taken into the trust and profits again became satisfactory from the standpoint of the combination. With some fluctuation they remained large until 1898. In that year competition was encountered from the Arbuckles. As, with this concern, the refining of sugar was incidental to the coffee business, it could afford for a time to refine for little or no profit. For a few years competition was extremely active and, apparently, as shown by the chart, profits for a time disappeared. In 1900 an understanding was reached with the Arbuckles and profits again rapidly rose. During the period 1901 to 1914 new refineries entered the field, the industry was subject to what may be characterized as healthy competition, and profits with some fluctuations remained comparatively steady, with a general tendency to decline until the opening of the Great War. Profits during the war period will be discussed later in this paper.

Effects of the tariff on profits.—There is little in the diagram to indicate any relation between profit and net protection. Under the

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portional to index numbers. This is confessedly an approximation and is adopted only because cost statistics are not available. Certainly, considering the average costs for the industry as a whole, there would be a tendency for them to follow the direction of index numbers. The most that is claimed for the method is that it probably approximates the truth more closely than the assumption of a uniform cost (even including costs due to loss in weight in raws) for the whole period—an assumption made in previous investigations. The latter method is almost certainly in error, neglecting as it does the very considerable variations in cost due to the fluctuation in price of raw sugar.

acts of 1870 and 1883 when the net protection was a little over 1 cent per pound there were periods both of large and small profits—large from 1880 to 1882, small from 1883 to 1887, and large again in 1888 and 1889. In 1890 the net protection was reduced to 0.5 of a cent and profits immediately fell to zero; but that this fall was in no way connected with the tariff is indicated by the fact that without any change in the tariff they began to rise in the following year, and by 1893 had attained a figure higher than any other shown on the chart. The act of 1894 was different in form from that of 1890, but the net protection remained substantially the same. Profits in no single year reached so high a point under the act of 1894 as under the act of 1890, but they averaged slightly higher. The act of 1897, from the time of its passage to that of the reciprocity treaty with Cuba (1903), brought a substantial reduction in net protection—from 0.4217 to 0.1381 of a cent per pound. It is true that the passage of the act was followed by a sharp decline in profits but, here again they immediately rallied and remained high until 1903, indicating that the decline was not due to the tariff. The effect of the Cuban reciprocity treaty, as time went on and the Cuban sugar dominated the United States market more and more completely, was to increase the net protection from 0.1381 to 0.5004 of a cent per pound, but no corresponding increase in profits is shown. In fact, from this point until 1916, profits, with yearly fluctuations, show a general tendency to decline. During this period the acts of 1909 and 1913 were passed. The former very slightly, and the latter considerably, reduced the net protection, but neither act is accompanied by a change of profits appreciable on the diagram. Changes in profits, however, as shown in the last paragraph, do synchronize with periods of combination and competition to so remarkable an extent as to suggest a causal relation, and it must be borne in mind that it was the net protection given to refined sugar which enabled the trust to advance its price and hence increase its profits during the periods in which it enjoyed a virtual monopoly. It may therefore be concluded that while the net protection did not directly affect prices and profits, it did indirectly affect both by making possible a monopoly price during the periods in which the trust was in control of the situation.[18]

[18] The first period of virtual monopoly was from 1887 to 1889. During this period the net protection was 1.0912 cents per pound. The second period of virtual monopoly was from 1892 to 1897, when the net protection was (act of 1890) 0.5 of a cent; (act of 1894) about 0.4217 of a cent per pound. The manner in which the net protection affords an opportunity for monopoly profit may be illustrated by the first of the above periods of virtual monopoly. Under the act of 1883 the duty on raw sugar was 2.24 cents per pound, and allowing for loss in weight and interest the cost to the refiner due to the duty was 2.4088 cents per pound of refined. Hence, if the duty on refined sugar had been only 2.4088 cents per pound, the American refiner would have been at no advantage over his foreign competitor, since his cost had been increased above that of this competition by the same amount. But the duty on refined sugar was in fact 3.5 cents per pound, hence the domestic price of refined could have been 3.5 cents above the foreign price of refined before foreign competition would be felt. But of this 3.5 cents, 2.4088 cents represented a cost to which the foreign competitor was not subject and hence a price higher than the foreign price by 2.4088 cents allowed no profit to the trust. Not until the domestic price had risen above the foreign price by more than 2.4088 cents could

States were unchanged, hence the equilibrium price would be the same as before, and the interests that would benefit by the reduction would be not the United States consumers but the Porto Rican, Hawaiian, and Cuban producers. The revenue from the duty was simply transferred from the United States Treasury to them.

The above line of reasoning calls for qualification to the extent that producers in the regions mentioned considered the United States, with the duty lowered or removed, a better market than others to which they had formerly exported. The increased supply offered would then find a market only at a somewhat lower price and the United States consumers would share with the exporting producers the benefit of the reduction of duty.

The increased profits would tend to stimulate production in the favored regions, but in the case of a commodity like sugar increased production is likely to be accompanied by increasing cost. Equilibrium would be attained when the cost to the least-favored producer was equal to the price. If the cost ascended rapidly with new units of supply so that the equilibrium point was reached without any considerable increase in supply, the consumer would never receive any appreciable benefit from the reduction of duty. The benefit would permanently go to the low-cost producers in the favored regions. If, on the other hand, the added supply could be produced without any considerable increase in cost for the new units produced, the consumer would ultimately receive virtually the entire benefit of the decrease in duty. The first supposition applied to Hawaii when sugar was admitted free under the reciprocity act of 1876. Production was stimulated, but, without very greatly increasing the supply relatively to consumption in the United States, at a rapidly increasing cost for the new units of supply. The consumer was not benefited by a reduction in price. The benefit went to the low-cost Hawaiian producers. The second supposition applied to Cuba when the preferential rate was granted in 1903. Here also production was stimulated, but so great is the available sugar land in Cuba that the increase in output was effected without any great increase in the new units of supply. Ultimately the consumer gained virtually the whole benefit of the reduction.[14]

When the reduction in duty is general instead of being applied only to a favored region, the effect is similar to the case of Cuba, but so great is the increase in supply now seeking the United States markets that the reduction in price to the consumer is much more rapidly effected. A case in point was the free admission of sugar

[14] For a full and careful discussion of the effect of the Cuban reciprocity treaty upon sugar prices, see "Reciprocity and Commercial Treaties," United States Tariff Commission, 1919, pp. 328–336. The conclusion there reached is that in the early years of reciprocity the benefit resulting from the reduction of duty went chiefly to the Cuban producers, but after about 1908 or 1909, chiefly to the American consumer.

under the act of 1890. Under the preceding act the average foreign price of sugar exported to the United States had been 2.98 cents per pound: under the act of 1890 it was 2.99 cents. World competition for the United States market prevented foreign producers from pocketing the gain from this revision of duty. On the other hand the average domestic price of refined sugar fell from 6.83 to 4.49 cents per pound. It thus appears that without any appreciable change in the foreign price of raws the domestic price of refined fell 2.34 cents per pound. The drop in the duty was only 2.24. The remainder of the benefit to the consumer was due to a drop in transportation costs.

Similarly, when the duty is increased, foreign producers, until they have accommodated their supply to the new conditions may be compelled to bear in whole or in part the increased burden of the tariff. There is some evidence that this was the case immediately after the act of 1894. This act increased the duty from zero to about 0.84 of a cent per pound. Referring to the chart (fig. 1) it will be seen that the foreign price of raws immediately fell from 2.9 to 2.1 cents per pound, and remained low during the three years covered by this act. So considerable was the decline that the position of the consumer of refined sugar was actually improved, the average price being slightly less than under the preceding act under which sugar was admitted free. In 1897 the duty was still further raised, but this time no further decline in foreign price is observable. This was the period of the Spanish War which presumably affected adversely conditions of production in Cuba, the chief source of supply, and so tended to keep up the foreign price.

III. COSTS, PRICES, PROFITS: WAR PERIOD.

1. Analytical Study of Costs and Prices in 1917.

Data and table.—Cost data were collected by the Commission from the principal refineries from 1914 to 1919, inclusive. The data are not complete. Some refineries are represented in some years and not in others, and several refineries are not represented at all. The data, however, are believed to be sufficiently comprehensive and typical to warrant important conclusions.

The following table (Table 5) analyzes for the year 1917, the year for which the Commission has the most complete data, the costs, prices, and profits of the refineries from which reports were received in that year:

TABLE 5.—*The costs, prices, and profits in the refining of sugar for the year 1917.*

[All columns except 1, 2, and 20 are in cents per pound of refined sugar; column 16, per pound of refined sugar sold; the others, per pound of refined sugar produced.]

Number.	Price of raws.	Cost of raws per pound refined.	Segregated items of refinery costs.							Total refinery costs.	Marketing costs.	Receipts for by-products.	Total costs.[1]		Price of refined.	Refiners' margin.	Profit.	Investment per pound refined sugar.	Profit expressed as percentage earning on investment.
			Labor.	Fuel.	Bone char.	Repairs and maintenance.	Containers.	Depreciation.	Other refinery costs.				Not including cost of raws.	Including cost of raws.					
1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20
1	5.769	6.268	0.160	0.142	0.017	0.068	0.224	0.083	0.173	0.887	0.066	0.185	0.768	7.036	7.455	1.686	0.419	2.80	15.0
2	6.103	6.239	.178	.073	.013	.027	.170	.012	.086	.559	.042	.129	.472	6.711	7.537	1.434	.826	.....	.....
3	5.869	6.195	.130	.040	.005	.050	.104	.018	.085	.432	.252	.080	.604	6.799	7.370	1.501	.571	5.01	38.1
4	6.111	6.590	.077	.117	.019	.069	.180	.025	.178	.665	.087	.066	.686	7.276	7.538	1.427	.262	1.82	14.4
5	5.823	6.358	.155	.073	.004	.064	.173	.024	.109	.602	.034	.128	.508	6.866	7.297	1.474	.431	1.08	41.7
6	6.135	6.640	.076	.127	.010	.060	.187	.000	.009	.469	.037	.039	.467	7.107	7.569	1.433	.462	1.23	37.5
7	6.012	6.393	.137	.068	.013	.041	.176	.023	.051	.509	.112	.165	.456	6.849	7.598	1.586	.749	1.28	58.4
8	6.195	6.638	.159	.111	.022	.080	.186	.099	.097	.754	.041	.103	.692	7.320	7.746	1.551	.416	2.03	20.5
9	5.778	6.334	.309	.157	.016	.024	.209	.092	.119	.926	.017	.235	.708	7.042	7.564	1.786	.522	.....	.....
10	6.896	7.681	.333	.124	.035	.084	.184	.000	.086	.836	.034	.176	.694	8.375	8.203	1.307	.172	.....	.....
11	5.847	6.268	.172	.080	.007	.043	.178	.113	.068	.661	.078	.149	.590	6.858	7.390	1.543	−.532	2.07	25.7
12	5.730	6.155	.231	.055	.025	.095	.211	.046	.061	.724	.045	.153	.616	6.771	7.332	1.602	.561	.....	.....
Average by—																			
Refineries	6.022	6.480	.177	.097	.015	.060	.182	.045	.093	.669	.070	.134	.605	7.085	7.550	1.528	.465	1.72	27.0
Poundage	5.893	6.320	.160	.104	.015	.067	.192	.060	.115	.713	.084	.154	.643	6.963	7.496	1.593	.523	1.[illegible]	[illegible].3

[1] Column 14—columns 11+12−13. Column 15—columns 3+11+12−13. Interest on investment not included in either.

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TABLE 5.—*The costs, prices, and profits in the refining of sugar for the year 1917.*

[All columns except 1, 2, and 20 are in cents per pound of refined sugar; column 16, per pound of refined sugar sold; the others, per pound of refined sugar produced.]

Number.	Price of raws.	Cost of raws per pound refined.	Segregated items of refinery costs.							Total refinery costs.	Marketing costs.	Receipts for by-products.	Total costs.[1]		Price of refined.	Refiners' margin.	Profit.	Investment per pound refined sugar.	Profit expressed as percentage earning on investment.
			Labor.	Fuel.	Bone char.	Repairs and maintenance.	Containers.	Depreciation.	Other refinery costs.				Not including cost of raws.	Including cost of raws.					
1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20
1	5.769	6.268	0.160	0.142	0.017	0.088	0.224	0.083	0.173	0.887	0.066	0.185	0.768	7.036	7.455	1.686	0.419	2.80	15.0
2	6.103	6.239	.178	.073	.013	.027	.170	.012	.086	.559	.042	.129	.472	6.711	7.537	1.434	.826	.....	.....
3	5.869	6.195	.130	.040	.005	.050	.104	.018	.085	.432	.252	.080	.604	6.799	7.370	1.501	.571	5.01	38.1
4	6.111	6.590	.077	.117	.019	.069	.180	.025	.178	.665	.087	.066	.686	7.276	7.538	1.427	.262	1.82	14.4
5	5.823	6.358	.155	.073	.004	.064	.173	.024	.109	.602	.034	.128	.508	6.866	7.297	1.474	.431	1.03	41.7
6	6.135	6.640	.076	.127	.010	.060	.187	.000	.009	.469	.037	.039	.467	7.107	7.569	1.433	.462	1.23	37.5
7	6.012	6.393	.137	.068	.013	.041	.176	.023	.051	.509	.112	.165	.456	6.849	7.598	1.586	.749	1.28	58.4
8	6.195	6.638	.159	.111	.022	.080	.186	.099	.097	.754	.041	.103	.692	7.320	7.746	1.551	.416	2.03	20.5
9	5.778	6.334	.309	.157	.016	.024	.209	.092	.119	.926	.017	.235	.708	7.042	7.564	1.786	.522	.....	.....
10	6.896	7.681	.333	.124	.035	.084	.184	.000	.086	.836	.034	.176	.694	8.375	8.203	1.307	.172	.....	.....
11	5.847	6.268	.172	.080	.007	.043	.178	.113	.068	.661	.078	.149	.590	6.858	7.390	1.543	—.532	2.07	25.7
12	5.730	6.155	.231	.055	.025	.095	.211	.046	.061	.724	.045	.153	.616	6.771	7.332	1.602	.561	.....	.....
Average by—																			
Refineries	6.022	6.480	.177	.097	.015	.060	.182	.045	.093	.669	.070	.134	.605	7.085	7.550	1.528	.465	1.72	27.0
Poundage	5.893	6.320	.160	.104	.015	.067	.192	.060	.115	.713	.084	.154	.643	6.963	7.486	1.593	.523	1.85	28.3

[1] Column 14—columns 11+12—13. Column 15—columns 3+11+12—13. Interest on investment not included in either.

Conclusions from table.—The most noteworthy matters brought out by the table are connected with (*a*) differences in costs and prices; (*b*) the relation of costs to prices and profits; and (*c*) the relative importance of specific items of cost.

(A) DIFFERENCES IN COSTS AND PRICES.

Costs.—Differences in costs are striking, as shown not only by total costs (column 15) but also the segregated items of cost shown in the other columns. The total cost per pound of refined sugar produced is seen to vary from 6.711 cents (factory 2) to 8.375 (factory 10), a difference of 1.664 cents. The highest cost factory is thus producing sugar at a cost 24.8 per cent higher than the lowest, and the difference (1.664 cents) is greater than the total cost of refining (not including cost of raws) of any refinery in the list (column 14). Circumstances connected with No. 10 were such as to render its case exceptional. Omitting No. 10, No. 8 is the highest cost refinery, and its total cost was 7.330, or 0.619 of a cent higher than the lowest. This difference, though exceeded by the total refinery costs of several factories, is greater than the average (0.605).

Explanation of diagram (*fig. 2*).—Between the extremes the other refineries range themselves gradatim. This is better brought out by a diagram. Figure 2 shows, for all the refineries reporting, the total costs (column 15), the costs of raws (column 3), the refinery costs (column 11), and the prices received for refined sugar (column 16). The total costs are proportional to the altitudes of the rectangles having the common base line OX and limited upward by the line AA′. The costs of raws are indicated by the altitudes of the rectangles having the same base line and limited upward by the line BB′, and the refinery costs by those limited upward by the line CC′. The average price received by all the refineries is indicated by the vertical distance from the base line to the line PP′, while the distances to the dotted lines QQ′, on either side of the line PP′, indicate the prices actually received by the several refineries.

Outputs.—The percentage outputs of the several refineries are indicated by the widths of the rectangles measured along the base line OX. To avoid identification, however, the outputs do not correspond with the costs and prices. For example, the price (OQ), the total cost (OA), the cost of raws (OB) and the refinery cost (OC) all apply to the same refinery, No. 2, but the output (OD) shown as applying to No. 2 in reality applies to another refinery. This method of construction correctly represents the general situation. It shows the great disparity in size of the refineries and the disparity in the several items of cost and price. It shows how large a proportion of the total cost is borne by the cost of raws, in comparison with which the re-

finery costs constitute but a small element. Being constructed from data arrayed in accordance with total costs, it shows the total costs ascending step by step from left to right, but as the total cost is made up of elements entering in different proportion, the lines showing refinery costs and costs of raws ascend and descend. The same is true also of the price line. The only important respect in which the diagram as drawn misrepresents the situation is in its failure to show the relation between the scale of production and the cost. Nothing can be inferred from the diagram as to whether large refineries have a low or a high cost.[a]

Prices.—Differences in prices are also striking whether the prices of raws (column 2) or the prices of refined (column 16) be considered. Differences in prices of raws are to be accounted for partly by differences in transportation expenses to the refinery, and partly by differences in the quality of the raws purchased, the average polariscopic tests ranging for the different refineries from 94.4° to 97°, but after making allowance for these causes something remains for difference in skill in purchasing. The differences in the prices received for refined are also due in part to differences in the character of the product sold. The great bulk is granulated, but some of the product is of a lower grade—"softs"—and some is of a higher grade or at least marketed in a different physical form, as cubes or crystals. The refineries differ considerably as to the proportion of the different kinds which they sell. Skill in marketing the product also accounts for some of the differences. Another cause of the difference in price of both raw and refined is to be found in the different proportions refined for export. The raws in this case will receive the drawback and the refined can thus be placed in a foreign market at a lower price.

Profits.—The profit per pound of refined sugar received by the several refineries above all costs, except interest on their productive investment, is shown by the vertical distance between the cost line AA′ and the dotted lines just above and below PP′. It will be seen that the profit is sometimes greater and sometimes less than would be obtained by using the average price. Refinery No. 10, which produced at a high cost (XA′) also received a high price (XQ′). Although operating at a loss (XA′—XQ′), the loss was not nearly so heavy as it would have been had it received only the average price (XA′—XP′). Refinery No. 1, operating at a rather high cost received a price below the average, thus reducing its apparent profits, while refinery No. 2, although operating at the lowest cost of all, yet received a price slightly above the average, thus adding to its apparent profit.

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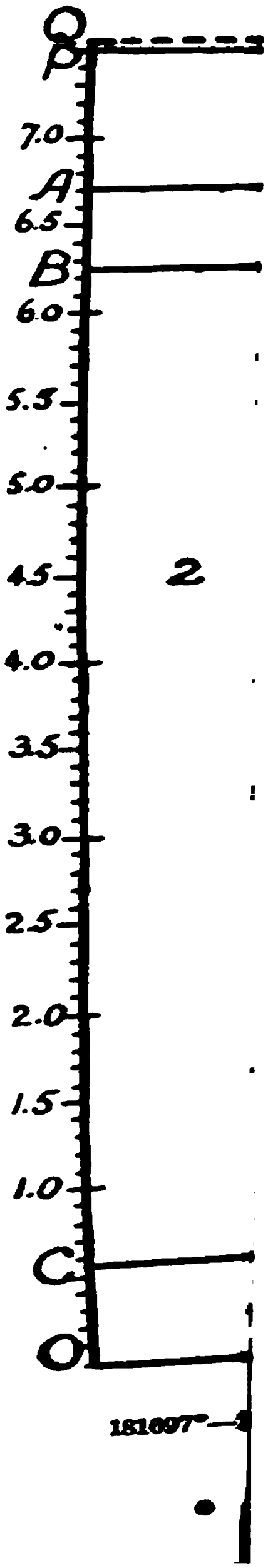
[a] This matter is, however, treated by a different method later in this report. See pp. 42, 43.

FIG.



(B) THE RELATION OF COSTS TO PRICES AND PROFITS.

A study of the table and the diagram shows, then, that sugar is refined by different refineries at very different costs. The price is seen to correspond with the highest, or nearly the highest cost refinery, a cost which for brevity may be called the marginal cost. This situation has long been understood by economists to apply to industries subject to the law of diminishing returns—specifically agriculture or extractive industries.[15] Now, while the manufacture of raw sugar is such an industry, the refining of sugar is not. It is distinctly a manufacturing rather than an agricultural industry. The refiners all have an equal opportunity to secure their raw material (sugar) at an approximately uniform price for whatever quantity they choose to buy. There is no such limit imposed upon the potential economies of large scale production as is imposed in the case of agriculture by limitations in the quantity of highest grade land. It would therefore be expected that the lowest cost refineries would increase their output, underbid their competitors, and either drive them out of business or compel them to improve in efficiency. There would therefore be a constant gravitation toward a uniform cost, which cost would be that of the low-cost refineries and this cost would determine the price. Doubtless such a tendency is operative. Nevertheless the diagram, figure 2, for the year 1917, as well as the diagram, figure 3, similarly constructed for the years 1914–1919, inclusive, indicate that in any given year other forces are operating, sufficient to seriously modify any such conclusion. Indeed, the diagrams closely resemble those constructed for the manufacture of raw sugar.[16] As in that case there is a marginal cost equal to the price, with perhaps a few refineries producing at an even higher cost and hence at a loss, and with the bulk of the sugar derived from refineries producing at progressively lower costs and hence receiving progressively higher profits.

Insofar as the condition described in the last paragraph is applicable to industry generally, its bearing upon governmental action in price fixing, whether by direct action or indirectly through the tariff, is apparent. It also has a bearing upon any action which the Government may undertake with reference to profiteering.

If the price, whether established by price fixing or by protection, is fixed at the figure which would have been established by free competitive conditions, it will be just sufficient to sustain the marginal refiner, from which point there will be a series of lower cost refiners receiving successively greater profit. If the price is fixed lower than the cost to the present marginal refiner, that price will determine a

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[15] See "Costs of Production in the Sugar Industry," Tariff Information Series, No. 9. p. 10 et seq.
[16] See Appendix B, "Costs of Production in the Sugar Industry."

new margin. Those formerly refining at a higher cost than margin will be driven out of business or forced to impro methods. Those refining at a lower cost will make less pr unless they increase the scale of their operations, or the s merly refined by the driven-out refiners is replaced by import there will be a scarcity, and the Government will be forced permit a higher price or undertake the distribution of sugar

Again, in regard to profiteering, assuming that there is no of restraint of trade or monopoly, can a producer be held et legally culpable for accepting the "going" price establishe competition? Yet this price is seen to be equal to the marginal or high-cost producer. Other producers, becaus greater efficiency, produce at lower costs and receive greater them very much greater, profits. Are they "profiteers?" 10 per cent on investment is considered a "fair" profit, is ducer, who, while receiving only the "going" or competiti yet because of his superior efficiency makes a profit of, say, per cent on his invested capital, to be regarded as a criminal

That the varying costs of production and the relation of cost to price were not simply due to the exceptional cond the year 1917, is shown by the cost and price lines in figure

In this diagram the total cost lines and the price line years 1914–1919, inclusive, are drawn in the same manr figure 2. It will be seen that as the war progressed both and price steadily rose, but in each year the two lines are of character and bear a similar relation to one another. The ascends by steps and is crossed by the price line at a point right-hand margin. A few high-cost refiners produce exceeding the price, the majority produce at a cost pro less than the price and receive progressively increasing pro will be noted that as the war progressed the price line tendency to rise more rapidly than the cost line. The pro sugar refined at a cost higher than the marginal cost decreased. This tendency reached its climax in 1917. T that year a much greater space between the price and cost l in any other year, indicating unusually large profits. dency was somewhat checked for the following two perio and the first six months of 1919—presumably by Governm lation.

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[17] In this diagram as in figure 2, the outputs do not correspond with the costs. See p. 25.

[18] For all the years the average price is taken. Strictly the price line like the cost line shou line (see dotted line, fig. 2) above the average for some refineries and below it for others, as received different prices for their sugars. It will be seen that the general conclusions deriv an average price line are only modified, not changed. Some factories receive a slightly gr slightly less, profit than the average price line would indicate.

(c) RELATIVE IMPORTANCE OF SPECIFIC ITEMS OF COST.

Raws (columns 2 and 3).—By far the most important item of cost is the cost of raw sugar. It represents over 90 per cent of the entire cost. A small relative difference in the cost of raws may therefore make a considerable absolute difference when it comes to be compared with the other costs of refining. A difference in the cost of raws may arise from two sources: (1) Differences in the price per pound paid for the raws, and (2) differences in the loss of weight incident to the process of refining. On an average it takes about 107 pounds of raw sugar to produce 100 pounds of refined, i. e., a loss of 7 pounds of raw for every 100 pounds of refined, but the actual loss varies considerably as between individual refineries. Obviously, such differences in loss when multiplied into the price of raw sugar result in great differences in refining costs. In this connection, however, it must be remembered that the raws differ in sucrose content. A considerable loss in weight due to low sucrose content may be neutralized by a low price. The point of this paragraph is to show that skill in bargaining in securing raws and skill in reducing loss of weight in refining them are the most important means of reducing the total costs of refining. Columns 2 and 3 show that different refineries vary greatly in both these respects. The difference between the highest and lowest price for raws is 1.166 cents per pound—more than the total of all the other costs of refining for any refinery, while the money loss, due to loss in weight (the differences as between columns 2 and 3) varies from 0.136 of a cent (No. 2) to 0.785 of a cent (No. 10) per pound of sugar refined. Omitting No. 10 the maximum loss is 0.535 (No. 5) a quantity over four times the minimum.

Containers (column 8).—Another large item of expense is the cost of containers. It stands second to cost of raws, exceeding labor cost, fuel cost, bone-char cost, marketing cost, the cost involved in maintenance and repairs, depreciation, or interest on productive investment. Here also there is much difference between individual refineries, the cost for containers varying from 0.104 to 0.224 of a cent per pound of sugar refined. While the relative difference is great—over 100 per cent—the absolute difference is not important, only about 0.1 of a cent.

Receipts for by-products.—This column (13) includes receipts for sirup, receipts for the sale of bags, and occasionally a few other items. As with the other columns great disparity is shown between the refineries. No. 9, for example, receives 0.235 of a cent from by-products for every pound of refined sugar produced, and thereby reduces its refinery costs (column 11) 21.8 per cent. No. 6, on the

other hand, receives 0.039 of a cent, and reduces its refinery costs only 8.3 per cent.[19]

Marketing costs (column 12) also vary greatly. With No. 3 they constitute a major item of costs; no other single item (except the cost of raws) is so great. With No. 9 no single item, except bone char is so small. Large marketing costs are presumably due in a large measure to advertising, and if the number of refineries from which data were received were large, say 30 or more, a correlation between marketing costs and profits would indicate whether such heavy outlay for advertising was profitable. As it is the number is too small to make such a correlation significant.[20]

Labor cost (column 4) varies from 0.076 to 0.333 of a cent per pound of sugar refined. The average is 0.160. As compared with the total average cost including raws, 6.963 cents, the average labor cost is seen to be a small item, only 2.5 per cent. Were wages doubled merely for the direct labor in refining, the cost of producing a pound of refined sugar would be increased only from 6.963 to 7.123 cents—about one-sixth of a cent per pound. This argument must not be pushed too far. It assumes that wages increase only in the business of refining sugar. Wage movements are usually general, and as wages enter indirectly into nearly all the other costs—fuel, supplies, marketing, etc.—a general increase of wages would affect the cost of refining sugar much more than the above figures would indicate.

The refiners' margin (column 17) is defined as the difference between the price of raws and the price of refined granulated. For the trade as a whole, in any year, it may be found by subtracting from the average price of refined granulated that of 96° centrifugals, New York quotations. Out of this margin the refiner must pay his expenses and make his profit. It therefore includes the following items: (1) Cost due to loss of weight in raws from the process of refining (column 3 − column 2); (2) refinery costs (column 11); (3)

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[19] It being optional with the refiner to increase or decrease, within limits, the importance of his sirup by-product, the question arises which policy is the more profitable. In the case of an individual refinery this would, of course, be determined by a comparison of results from year to year, as shown by its books. The results would depend, among other things, upon the relative prices of sugar and sirup. In the absence of such detailed information, some inference could be drawn by the method of correlation. The results would be valuable if the number of refineries were large. With only 12, little or no significance can be attached to the result. The correlation between columns 12 and 14 (refinery costs and receipts from by-products) is $r = +0.692 \pm 0.106$, and the correlation between columns 14 and 19 (receipts for by-products and profits) is $r = +0.196 \pm 0.196$. Thus, while there is a considerable correlation between receipts for by-products and refinery costs, indicating that emphasis upon by-products adds appreciably to costs, the indication that profits are thereby increased is negligible. The correlation, though positive, is small and is equaled by the probable error. The number of refineries, however, is so small as to preclude any conclusive inferences from this method. In cases where the number of establishments from which data were obtained was large, the method might be employed to advantage.

[20] The correlation referred to is $r = +0.197 \pm 0.195$. If heavy outlay in advertising were unmistakably reflected in higher profits, this would have shown itself by a high correlation. All that can be inferred from so low a correlation with so high a probable error, is that heavy outlay for advertising may be overdone and is a questionable policy.

marketing costs (column 12); (4) a deduction from the above sum of the receipts for by-products (column 13); (5) and profits (column 18).

The refiners' margin obtained from average New York quotations differs somewhat from that obtained from the average of the columns in the above table or from that realized by any individual refinery. From the yearly average of New York quotations for 1917 the margin is 1.435 (7.663 average price refined granulated—6.228 average price 96° centrifugals).[21] From the table the average refiners' margin is 1.593 (7.486 average price refined—5.893 average price raws). In the case of individual refineries the difference is still greater. No. 10 shows a refiners' margin of 1.307; No. 9, of 1.786. These differences are to be accounted for in part by the fact that the raws actually purchased may be higher or lower than 96° centrifugal, and that the sugar actually sold is not all granulated. Individual skill in bargaining, both in buying and selling, also plays a part. So far as averages are concerned, in a year of rising markets, such as 1917, the margin actually received might be expected to be greater than that computed from average New York quotations; the raws would be purchased on a lower range of prices than would prevail when the granulated refined from them was sold.

Return on productive investment (*columns 19 and 20*).—In studying the schedules for investment, only such investment as was directly related to the business of refining sugar was admitted. Outside investment in bonds, stocks, or other interests were rigidly excluded. The productive investment so obtained was then divided by the output, giving investment per pound of refined sugar. Considerable variation is observable. Refinery No. 5 shows only 1.03 cents per pound of refined sugar, while refinery No. 1 shows 2.8 cents—nearly three times as much. The average is 1.72. By dividing column 18 by column 19 the percentage return on productive investment can be obtained. The results are shown in column 20. It will be seen that such percentage profits vary from 14.4 per cent to 58.4 per cent, the average being 27 per cent.

2. Effect of the War on Costs, Prices, and Profits.

General tendency of costs as shown by graphical method.—In each year of the war, as is shown by figure 3,[a] the several refineries operated at varying costs, giving the cost line the appearance of a flight of steps, but in each year the steps start and terminate on higher levels than on the preceding year. The cost for the lowest cost refinery in 1915 is about the same as that of the highest cost refinery in 1914; the cost of the lowest cost refinery in 1916 is considerably higher than that of the highest cost refinery in 1915. Similar relations are observable between 1917 and 1916, 1918 and 1917, and 1919 and 1918.

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[21] See Table 6, p. 32.

[a] See diagram facing p. 28.

TABLE 6.—*Averages, by refineries and by poundage, for 12 refineries, showing the several items of the cost of refining sugar, for the years 1914–1919.*

[Averages expressed in cents per pound.]

Items of cost and price	1914		1915		1916		1917		1918		Six months of 1919.	
	Average by—		Average by—		Average by—		Average by—		Average by—		Average by—	
	Refineries.	Poundage.	Refineries.	Poundage.	Refineries.	Poundage.	Refineries.	Poundage.	Refineries.	Poundage.	Refineries.	Poundage.
Price of raws per pound of raw	3.520	3.530	4.541	4.527	5.510	5.518	6.022	5.803	6.219	6.260	7.223	7.213
Cost of raws per pound refined	3.735	3.717	4.852	4.803	5.969	5.968	6.480	6.320	6.693	6.717	7.696	7.698
Total refinery cost	.431	.420	.416	.424	.453	.452	.669	.713	.931	.961	.856	.889
Items of refinery cost:												
Labor	.105	.102	.106	.107	.126	.127	.177	.180	.273	.272	.237	.248
Fuel	.060	.050	.051	.044	.058	.046	.097	.104	.126	.129	.117	.124
Bone char	.012	.010	.011	.010	010	.009	.015	.015	.018	.019	.017	.017
Repairs and maintenance	.024	.021	021	.019	.022	.020	.060	067	.041	.042	041	.043
	.132	.132	.136	.140	.129	.141	.182	.192	.291	.294	.299	.305
	.012	.013	.012	.013	012	.013	.045	.060	.027	.047	038	.045
	.086	.092	.081	.091	.096	.094	.093	.115	.155	.158	.107	.107
	.089	.080	.092	.086	.102	.092	.070	.084	.092	.086	.104	.100
	.054	.056	.065	.075	.088	.098	.134	164	.194	.215	.128	.170
	466	444	.445	435	.467	.445	.605	.643	.829	.832	832	.819
	4.201	4.161	5.298	5.238	6.436	6.314	7.085	6.963	7.522	7.549	8.528	8.517
Price of refined	4.207	4.321	5.384	5.371	6.455	6.453	7.550	7.486	7.652	7.740	8.844	8.881
Profit	.106	.160	.086	.133	.019	.139	466	522	.130	.191	.316	.364
	.737	.701	842	.844	.945	935	1.528	1.503	1 433	1.499	1 641	1 668
r	a 1.72	a 1.85	a 1.72	a 1.85	a 1.72	a 1.85	1.72	1.85	a 1.72	a 1.85	a 1.72	a 1.85
rep-	6.16	8.64	5.00	7.19	1.11	7.51	27.0	23.3	7.56	10.32	18.37	19.67
New		3.814		4.642		5.786		6.226		6.447		b 7.61
New		4.683		5.559		6.932		7 663		7 834		b 9.00
uota-		.869		.917		1.076		1 435		1.387		b 1.38

a Computed from 1917 data.

b The averages for 1919 were obtained from weekly quotations, Willett & Gray. The price fixed by the Board of Equalization (7.26 for 96° centrifugals and 9 for refined granulated) prevailed throughout the year, except that the last three quotations for new crop Cubas (Dec. 18, 24, and 31) were 13.55, 13.04, and 12.79, respectively.

Average costs 1914–1919.—The tendency of costs to increase is clearly shown by the graph, but the magnitude of the increase can be best studied by the method of averages. Table 6 shows, in averages by refineries and averages by poundage,[22] the prices and several items of cost, by years, during the period 1914–1919, for the refineries from which reports were received, and Table 7, derived from Table 6, shows the percentage increase (+) or decrease (−) in the case of the several items for each year as compared with the preceding year, and also for 1919 as compared with 1914.

TABLE 7.—*Annual percentage increase in the several items of cost and price, 1914–1919. Averages by poundage used.*

[Negative sign (−), decrease.]

Items of cost and price.	1915 over 1914.	1916 over 1915.	1917 over 1916.	1918 over 1917.	1919 over 1918.	1919 over 1914.
Price of raws per pound of raw	28.2	21.9	6.8	6.1	15.4	104.3
Cost of raws per pound of refined	29.2	22.2	7.7	6.3	14.6	107.1
Total refinery cost	.9	6.6	57.7	34.8	− 7.5	111.7
Items of refinery cost:						
Labor	4.9	18.6	26.0	70.0	− 8.8	143.1
Fuel	−12.0	9.1	116.7	24.0	− 3.9	148.0
Bone char	.0	−10.0	66.7	26.7	−10.5	70.0
Repairs and maintenance	− 9.5	5.3	235.0	−37.3	2.4	104.8
Containers	6.1	.7	36.2	53.1	3.7	131.1
Depreciation	.0	.0	361.5	−21.7	− 4.3	246.1
Other refinery costs	− 1.1	3.3	22.3	37.4	−32.3	16.3
Marketing costs	7.5	7.0	− 8.7	2.4	16.3	25.0
Receipts for by-products	33.9	30.6	57.1	39.6	−20.9	203.6
Total, not including raws	− 2.0	2.5	44.2	29.4	− 1.6	84.5
Total, including raws	25.9	20.5	10.3	8.4	12.8	104.7
Price of refined	24.3	20.1	16.0	3.4	14.7	105.5
Profit	−16.9	4.5	276.2	−63.5	90.6	127.5
Refiners' margin	6.7	10.8	70.4	− 6.5	11.9	110.9

TENDENCIES OF SPECIFIC ITEMS.

Raws.—A study of these tables show that the advance in the cost of raws began in 1915 and has continued steadily to the present time. The cost was 29.2 per cent higher in 1915 than in 1914 and 22.2 per cent higher in 1916 than in 1915. For the next two years the advance, though continuous, does not show so high a percentage increase (7.7 and 6.3) but in the next year, 1919, the cost mounted to 14.6 per cent higher than in 1918. Taking the whole period the cost of raws to the refiner was in 1919 more than double the cost in 1914 (107.1 per cent).

Refinery costs do not show any great increase till 1917. They averaged only 0.9 of 1 per cent higher in 1915 than in 1914 and only 6.8 per cent higher in 1916 than in 1915. In 1917, however,

[22] Averages by refineries were obtained by adding the costs per pound of sugar refined for each refinery and dividing by the number of refineries. Averages by tonnage were obtained by adding the total outlay in dollars for the several items of cost for each refinery and dividing by the total output of refined sugar for all the refineries. The average by refineries is thus the average cost to the several refineries regarding each refinery as an indivisible unit. The average by poundage is the average cost at which sugar is refined, regarding the pound of sugar as the unit. The cost of all the pounds, irrespective of refineries, is divided by the number of pounds refined.

they increased 57.7 per cent over 1916, and again in 1918 the increase is 34.8 per cent over 1917. In 1919 a decrease is shown (7.5 per cent). Taking the period as a whole refinery costs also more than doubled (111.7 per cent).

With respect to the several items of refinery cost it will be seen that they show a general tendency to increase, especially marked in 1917, with a decided reaction in 1919. For the whole period most of these costs have considerably more than doubled. Labor increased 143.1 per cent; fuel, 148 per cent; bone char, 70 per cent; repairs and maintenance, 104.8 per cent, and containers, 131.1 per cent. It is to be noted that though the labor cost advanced 143.1 per cent during the period, the actual increase due to the *labor directly concerned in refining sugar* was only about one-seventh of a cent (0.146) per pound. Inasmuch, however, as labor enters indirectly into nearly all the items of cost, especially the cost of raw sugar, the *general advance* in wages is undoubtedly responsible for a large, perhaps the larger, part of the increased cost.

Marketing costs for the whole period increased only 25 per cent, indeed in 1917 and 1918 they were actually less than in 1915 and 1916. Apparently, Government control simplified marketing problems for the refiners. Moreover, because of the scarcity, sugar "sold itself" during the period without much effort or expense to find purchasers.

Receipts for by-products increased greatly during the period. The scarcity of sugar tended to increase the demand for sirup, causing a great rise in price. In one refinery sirups that were selling at 11 and 12 cents per gallon, sold at 50 and 60 cents in 1919. In another, molasses rose during the same period from 3.7 to 15 cents per gallon. Under the head of by-products are included also raw sugar bags. For these also there was a sharp advance in prices.

Total costs.—Summing all these items together (cost of raws, refinery costs, and marketing costs), even after making a deduction for the increasing receipts for by-products, it will be seen that the total cost has steadily increased since 1914 to the present time. It is 25.9 per cent higher in 1915 than in 1914; 20.5 per cent higher in 1916 than in 1915; 10.3 per cent higher in 1917 than in 1916; 8.4 per cent higher in 1918 than in 1917; and 12.8 per cent higher in 1919 than in 1918. Altogether the total cost in 1919 is more than double (104.7 per cent) what it was in 1914.

Prices.—But if costs have advanced, so also have prices. The advance in the price of raws, as is to be expected, roughly parallels the advance in the cost of raws to the refiner, the cost per pound of refined for each year being somewhat greater than the price because of the loss of weight in refining. The price of refined has also advanced year by year. It was 24.3 per cent higher in 1915 than

in 1914; 20.1 per cent higher in 1916 than in 1915; 16 per cent higher in 1917 than in 1916; 3.4 per cent higher in 1918 than in 1917; and 14.7 per cent higher in 1919 than 1918. For the whole period the advance in the price of refined closely paralleled the advance in the total costs (105.5 as compared with 104.7).

Profits and returns on productive investment.—It will be noticed that in every year the profits when obtained by the method of averaging by refineries are less than when obtained by the method of averaging by poundage.[23] Such a result suggests economy in large scale production, of which more will be said in a later paragraph. But by whichever method the average is obtained the profits are moderate until 1917. Averaging by poundage the returns on productive investment are 8.64 per cent in 1914; 7.19 per cent in 1915, and 7.51 per cent in 1916; and averaging by refineries they are even less, 6.16 per cent, 5 per cent, and 1.11 per cent[24] for the same three years, respectively. With 1917, however, profits make a sudden advance. When averaged by refineries, it is seen that from less than 2 cents on a hundred pounds of sugar in 1916 they jump to over 40 cents on a hundred pounds in 1917. When averaged by poundage, the advance is not so great—from about 14 cents per hundred pounds to over 52 cents per hundred pounds—but still great enough to be startling, representing as it does a return of over 28 per cent on productive investment and an increase over the preceding year of 276.2 per cent. Moreover, this advance is made in spite of writing a generous portion of current income to depreciation. From about 1⅓ cents per hundred pounds charged to depreciation in 1916, this charge was increased to 6 cents per hundred pounds in 1917, an increase of 361.5 per cent.

In 1918 profits returned to about the level of 1914. Averaging by refineries they were 10.6 cents per 100 pounds in 1914, and 13 cents per hundred pounds in 1918. Averaging by poundage they were 15.9 cents per hundred pounds in 1914 and 19.1 cents per hundred pounds in 1918. On the surface this looks like a considerable advance, but considering the decreased purchasing power of money, as shown by index numbers, profits appear to have been actually less in 1918 than in 1914.[25] In 1919 there is again a sharp advance in profits to a level much higher than normal, but not quite so high as in 1917. Averaging by refineries they are 31.6 cents per 100 pounds, and by poundage, 36.4. Perhaps the most instructive way of studying the fluctuations of profits during the war period is

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[23] See footnote, p. 33, for distinction between above types of average.

[24] Several small refineries operated at a loss in 1916, thus bringing down the average by refineries to the low figure given in the text.

[25] The increase in profits is about 20 per cent, whether averages by poundage or averages by refineries are used. The index number, however, increases from 99 in 1914 to 194 in 1918, almost double. See History of Prices during the War, p. 9.

to consider them in terms of the percentage return on productive investment. Such a comparison is made in Table 8:

TABLE 8.—*Average profits in the years specified, expressed as percentage of productive investment.*

Average by—	1914	1915	1916	1917	1918	1919
Refineries	6.16	5.00	1.11	27.0	7.56	18.57
Poundage	8.64	7.19	7.51	28.3	10.32	19.67

3. GOVERNMENT REGULATION OF PRICES.

During the war the national Government, through the United States Food Administration and the Sugar Equalization Board, undertook the regulation of the price and distribution of sugar. The successive steps in this administration of the industry are given in outline in the following paragraphs:

Suspension of dealing in sugar futures—Export control.—One of the first results of Government intervention was the suspension of all dealing in sugar futures on the New York Coffee and Sugar Exchange. On August 16, 1917, the following notice was issued: "The board of managers of the New York Coffee and Sugar Exchange (Inc.), acting on the suggestion of Mr. Hoover of the Food Administration Board, has suspended all trading in sugar futures on the exchange until further notice." The exchange was not opened for this business until February 16, 1920.

Another early act of the Food Administration, acting in cooperation with the War Trade Board, was to inaugurate a policy of rigid control over all sugar exports, which control was maintained throughout the war period.

Voluntary agreement with beet-sugar factories and Pacific coast refineries.—Regulation of prices began in the fall of 1917 when by voluntary agreement with the refineries on the Pacific coast and with the beet-sugar factories, it was arranged that, after deducting trade discounts, 7.25 cents per pound f. o. b. seaboard refining points should be the basic price for refined granulated, to which price, for other points in the country, the freight from New York was to be added. This price was to apply to the beet crop whose harvesting began in California in the summer of 1917 and proceeded eastward through the fall and winter months of the same year.

It was to be effective from October 1 in a region west of a line passing through Chicago and St. Louis. East of this line the price of refined granulated was to be 8.40 cents per pound, but as the harvesting of the beet crop proceeded the 7.25 basic price [26] was to move eastward until it applied to the whole country.

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[26] Changed to 7.35 cents on Dec. 12 and to 7.45 on Jan. 8 following. Changes made essential by the agreement with the Cuban producers.

Louisiana.—The case of Louisiana presented some difficulties, both because of the partial failure of the crop and because of the considerable number of grades produced. The American Sugar Refining Co. endeavored to secure 100,000 tons of raw at 6.35 per pound, but succeeded in obtaining only 26,000 tons. After many negotiations the Food Administration and the planters agreed upon a price of 7.80 less 2 per cent for plantation granulated and 7.25 less 2 per cent for clarified. At these prices it became the object of every factory to put out the best grade possible. For the 1918–19 crop (to anticipate a little) it was agreed by the planters (Sept. 19, 1918) to sell their sugar to the United States Food Administration at the basic price of refined granulated (9 cents per pound with customary discounts) less certain differentials for the various Louisiana grades, as, for Plantation Granulated, no differential; for White Clarified, 10 cents per hundredweight; for Choice Yellow Clarified, 15 cents per hundredweight; for Prime Yellow Clarified, 20 cents per hundredweight; for Kettle, 20 cents per hundredweight, etc. The 1919–20 crop was again a partial failure, and the planters claimed that their costs per pound of sugar produced were so high that they must receive a price of at least 17 cents per pound to make good. A conference was held with the Attorney General, as a result of which he approved the price of 18 cents per pound for Plantation Granulated and 17 cents for Prime Yellow Clarified, intermediate grades in proportion.

The International Sugar Committee—1.3 cents margin to refiners.—In October of the same year a committee was appointed by the United States Food Administration known as the International Sugar Committee, to cooperate with the Royal Commission on the Sugar Supply in the purchase of the imported raw sugar requirements of the United States, and of the other nations at war with Germany, and to arrange for the apportionment of such importations to refiners. An arrangement was effected by the Food Administration with the refiners that they were to be allowed a margin of not more than 1.3 cents per pound, fine granulated f. o. b. refinery, above the duty paid price of 96° centrifugals, as determined by the International Sugar Committee, provided that prices were not less than 5¼ nor more than 6 cents per pound. If less than 5¼ cents, the margin was to be less, and if more than 6 cents, more than the 1.3 cents. The 1.3 cents margin was to apply after the customary trade discount had been deducted from the list price.

Purchase of 1918 Cuban crop.—In December arrangements were made with the Cuban planters for the purchase of 3,200,000 tons of sugar at a price of 4.60 f. o. b. Cuba which, allowing for duty, freight, and other charges, amounted to 6.005 f. o. b. New York. Accordingly announcement was made that after January 7, 1918, the basic price

for 96° centrifugals should be 6.005, from which a price of 7.45 for refined granulated was derived, computed as follows:

Price of 96° centrifugals	6.005
2 per cent discount on 7.45	.149
Margin	1.296
	7.45

The margin received by the refiners was thus 1.296, or 0.004 of a cent less than the maximum allowed.

The prices of raw and refined, as above determined, remained unchanged until the fall of 1918, except that during the summer, because of increased war risk insurance, the basic price of Cubas was changed from 6.005 to 6.055, and the price of refined accordingly rose from 7.45 to 7.50.

Regulation of distribution.—A competitive price always equalizes demand and supply. When the price is kept below the competitive price, as in this instance, the demand will tend to exceed the supply. An artificial price, therefore, calls for regulation in the matter of distribution. In order that each person should have some part of the limited stock (though not so much as he would have been willing to take at the artificially low price) each person must be put under some restraint. During the summer such restraint was imposed. It was announced that on July 1, 1918, and thereafter the distribution of sugar would be conducted under the direction of the United States Food Administration. Certificates were issued to wholesalers, retailers, manufacturers, eating houses, in fact to all buyers except household consumers, and refiners, and other sellers were instructed to sell only on presentation of certificate. Users of sugar entitled to certificates were divided into five classes as follows: A. Manufacturers of candy, soft drinks, chewing gum, chocolate, cocoa, flavoring extracts, invert sugar, sirups, sweet pickles, wines, and tobacco preparations. B. Commercial canners of vegetables, fruit, and milk, and users for medicinal purposes, explosives, and glycerine. C. Hotels, restaurants, clubs, dining cars and steamships, boarding houses, hospitals, public institutions, and public eating places. D. Bakers and cracker manufacturers. E. Retail stores and others selling for direct consumption. These groups were classified as more or less essential industries, and were rationed accordingly. Users in group A were permitted 50 per cent (ice cream makers 75 per cent) of their requirements for the same period of the previous year; users in group B were permitted their full requirements; users in group C, 3 pounds for each 90 meals served; users in group D, 70 per cent of their requirements for the same period of the previous year; and users in group E, an amount equal to the average sales for April, May, and June, 1918. For household use the following regulations were announced: Sales to town and city consumers for household use were limited to parcels

of 2 pounds, and to rural consumers to parcels of 5 pounds, and householders were asked to adopt a sugar allowance of 3 pounds of sugar per person per month. Moreover, by a practice instituted by the grocers and acquiesced in by the Food Administration, the sale could only be made in connection with other purchases, usually to the value of a dollar. Sugar for home canning was limited to 25 pounds, and was to be sold only on presentation of a certificate issued by the Federal Food Board or a deputy of the Food Administration. The "certificate plan" continued in operation until December 1, 1918.

The Sugar Equalization Board.—In the summer of 1918, also, for the purpose of equalizing costs and better regulating the distribution of sugar, a corporation was chartered under the laws of Delaware, with a capital of $5,000,000, to be subscribed by the President of the United States, under the name of the Sugar Equalization Board. From this time on the Sugar Equalization Board cooperated with other departments of the Food Administration in handling the sugar situation.

Refiners request an increase in margin.—By the summer of 1918 it became evident that because of advancing costs of production a further advance in price both of raw and refined sugar would be necessary. The cane-sugar refiners as early as May had requested that they be allowed an increase beyond the 1.30 margin allowed by the contract of October 1, 1917. This request was referred to Oscar S. Straus for investigation. He reported in brief that (1) for the period from January to June the 1.30 margin had been sufficient, and (2) that if the cost of labor and commodities went no higher and if the refineries continued to show at least the same volume of meltings, 1.30 would be sufficient for the remainder of the year. But he held that if the lack of arrivals of raws prevented the refineries from working to capacity—or at least to as near capacity as before—and that if there was an increase in the cost of labor and materials including fuel and containers, an increase in price should be allowed; and he referred the matter to the Food Administration to determine whether such increase in costs had taken place or was likely to take place.

Transfer of old crop sugars to equalization board and retransfer to refiners.—As a result of these investigations it was announced during August that the price of refined sugar would be increased, but until the price at which Cubas could be obtained was known, the exact amount of the increase could not be stated. As it was not considered fair, however, that refiners should obtain the new price for sugar refined from raws purchased at the old price, the following arrangement was made. The refiners were to transfer virtually at cost to the Sugar Equalization Board all sugars owned on the date that the price was raised, and all sugar due them under contract of December 24 between the International Sugar Committee and the agents of

various Cuban sugar producers. The board would then ... resell to them at a price based on the increased p... sugar. Moreover old crop domestic sugars (cane a... be purchased by the Sugar Equalization Board o... and immediately resold to the same parties a... These transfers were to be made at a date to ... were to apply to all sugar held by cane-su... and beet sugar producers wherever loca... transit and undelivered. It was not t... shipments.

Margin of 1.45 cents per pound ... the committee to whom Mr. Str... 1.45 instead of 1.30 was to be allow... add 15 cents per hundred pounds to the... the new price went into effect. In the mean... referred to the United States Tariff Commission to ... amination of the books and accounts of the refiners whet... operation 1.45 was less or more than a just and adequate ma...

New price of refined granulated, 9 cents per pound, announced.—The new price was finally announced to take effect September 9, 1918. It was to be 9 cents per pound less 2 per cent on the basis of refined granulated, and was computed as follows:

	Cents per pound.
New basic price for raws	7.28
New refiners' margin	1.45
7 per cent on increased price of raws [a]	.09
2 per cent discount on 9 cents	.18
	9.00

Price for new crop Cubas fixed at 5.50 cents per pound.—The above basic price for raws applied to sugars produced in Louisiana, Texas, Porto Rico, and St. Croix. The Hawaiians under an old private contract sold for a less price. Haitian, Peruvian, and other full duty paying raws were taken in moderate quantities at 5.64 c. i. f., or about 6.90 duty paid. The new crop Cubas, the most important single source of sugar, were, after considerable negotiations with the planters, purchased by the Sugar Equalization Board, representing the United States, and the Royal Commission of Sugar Supply, representing Great Britain, at a price of 5.50 cents per pound f. o. b. Cuba, or about 6.90 c. i. f. duty paid, New York. The Sugar Equalization Board sold to refiners at 7.28, the basic price for other raws, thus making a profit of 0.38 cent per pound, which profit after defraying the necessary expenses of the board was covered into the United States Treasury.

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[a] 7.28 (new price of raws)—6.055 (old price of raws)=1.225. 7 per cent of 1.225=(approximately) .09. The allowance was placed at 7 per cent because that is approximately the loss of weight of raws in refining.

Quantity purchased.—Under the arrangement described in the last paragraph the Equalization Board was to have two-thirds of the available Cuban crop for distribution in the United States and the Royal Commission one-third for distribution in Europe. After deducting from the entire Cuban crop 208,510 tons for local consumption and shipment to neutral countries, there remained 4,239,879 tons, two-thirds of which, or 2,826,585 tons, went to the Sugar Equalization Board. Of the Royal Commission's share 581,840 tons were refined in the United States. The subsequent shipment of this sugar to Europe gave rise to a rumor in the United States, during the period of scarcity, of enormous exports by refiners for a higher price while the American people were suffering for want of sugar. It is true that during the year moderate exports were permitted by the Equalization Board for reasons that will be presently explained, but the above shipments were not properly in the nature of exports at all. The sugar belonged to the Royal Commission, who found it convenient to have it refined in the United States.

Maladjustment of supply to demand.—In the early part of 1919 there appeared to be an excess of supply and the Equalization Board began to consider proposals for the sale of a part of their Cuban purchases abroad; 133,603 tons were so disposed of. As the season progressed arrivals from Cuba became more abundant, the demand for refined was light, and sugar, both raw and refined, accumulated in the warehouses of the refiners. One refinery in order to dispose of its surplus slightly cut the price. The Equalization Board, on the urgent request of the refiners to come to their aid, suggested to consumers, through published advertisements, the propriety of laying in their supplies. This propaganda, together with other circumstances, among which the most important were the exhaustion of the 1918–19 beet-sugar crop, the lifting of the refined sugar belonging to the Royal Commission and the rapid absorption of the Javan crop, brought about, early in May, a sudden change. Orders began to pour in, and from a condition of surplus the country passed to a condition of scarcity, which, aggravated by harbor strikes and an unprecedented demand for sugar, continued with increasing severity throughout the year.

As early as July, in the general expectation that Government control would end with the year, purchases began to be made of the 1919–20 Cuban crop. The prices paid were then about 6.50 f. o. b. Cuba (a full cent above the price paid by the Equalization Board for the 1918–19 crop) and the price steadily advanced to the close of the year.

Equalization Board continued.—In August, 1919, the Equalization Board received an offer from Cuban producers to negotiate for the 1920 crop, and this offer was transmitted to the President with the

recommendation that it be accepted—one member dissenting. No action, however, was taken at this time, but in October under pressure from the public, suffering from the increasing sugar shortage, Congress took the matter in hand in the form of the McNary bill for continuing the Equalization Board for another year. In amended form the bill finally passed, and was signed by the President on December 31, 1919. The act continues the Sugar Equalization Board for another year with broad powers over the control and distribution of sugar. It continues the licensing provisions of the Lever food control act of August 10, 1917, to June 30, 1920, as to the domestic product, and to December 31, 1920, as to all other sugars. It does not, however, provide for the power of export embargo nor the power of rationing through the "zone" arrangement, which powers the Board deemed necessary for effective work. The purchase of the Cuban crop is left to the discretion of the President, who has let it be understood that it is unlikely that this power will be exercised.

Bearing of Government price regulation on profits.—Returning now to Tables 6 and 7 and considering profits in the light of the successive steps in Government intervention, it will be seen that though price regulation was begun in 1917, it did not apply to refiners, to any appreciable extent, until 1918 when the new crop Cubas began to appear; 1917 was, therefore, for the refiners a year of unregulated prices, and the enormous profits for that year merely reflect the logical results of strong demand and scarcity of supply. The profits of 1918 were about normal [27] (assuming the prewar profits of 1914 to be normal), thus indicating that the Food Administration's price adequately protected consumers and yet was not too drastic for refiners. Profits in 1919 were much higher and Government regulation still continued. In forming a judgment as to whether the Government price allowed the refiners was too high, two facts should be considered: (1) The price was arranged before the armistice, at a time when it was reasonably expected that costs would be much higher; (2) the consumption of sugar for 1919 was unprecedented, and besides the sugar refined for domestic consumption large quantities were refined for the Royal Commission. The refineries therefore operated to full capacity—one of the most important factors in reducing the cost per pound.

4. Relation Between Costs and Profits and the Scale of Production.

Averages by refineries and averages by poundage.—In an average by poundage the costs or profits of the large refineries have a greater weight in determining the average cost or profit than the small refineries, while in an average by refineries all refineries have the

[27] See p. 35 and footnote.

same weight. Hence the average cost or profit by poundage tends to conform to the cost or profit of the large refineries, while in the average by refineries there is no such tendency. It follows, then, that if, when averaging by poundage the cost is smaller or the profit larger than when averaging by refineries, the inference is that there is economy in large-scale production.[28]

Studying the averages in the light of this principle, it will be seen that there is no very marked tendency in favor of the large refinery—certainly no such marked tendency as is observable in the case of the manufacture of raw sugar.[29] Taking cost of raws the evidence is in favor of the large establishment in 1914, 1915, 1916, and 1917, but not in 1918 and 1919. Taking refinery costs the evidence is in favor of the smaller establishments in every year except 1914 and 1916. Taking marketing costs the evidence is for the large establishments in 1914, 1915, 1916, 1918, and 1919, and for the small establishments in 1917. Taking receipts for by-products the evidence is decidedly for the large establishments in every year. It thus appears that taking the items of cost separately the evidence is inconclusive, but when all of these items are combined and deducted from the price, thus obtaining the profit, the evidence points strongly to the advantage of the large establishments. For every year the average by poundage is distinctly larger than the average by refineries.

An optimum size.—A more detailed study of costs and prices than can be here made without revealing the identity of individual factories would seem to confirm for the refining industry, the economic concept of an optimum size, i. e., that the economies of large-scale production prevail up to a certain point, after which there is little or no gain in increasing the size of plant.

Large-scale production and combination.—Again there is internal evidence that in considering the economies of large-scale production, it makes a difference whether the large-scale production was attained under competition or in an effort to secure monopoly. The promoters of the former sugar monopoly in order to induce competing establishments to come into the combination appear to have made concessions to some of the competitors, which resulted in incorporating in the "trust" units of comparatively low efficiency. Hence, from a business point of view, however much this may have been justified by *monopoly* profit, it was not justified by that form of profit which flows from the economy of large-scale production.

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[28] The inference may not be justified. If some other circumstance is always present with the large establishments which is absent from the small establishments it may be this other circumstance which is the cause of the economy and not the scale of production. The sugar factories of Cuba average much larger in size than those of Louisiana and also show a much lower average cost of production. But in this case the lowness of cost is due to the fact that they are in Cuba rather than to the fact that they are large. Nevertheless, where no such universal concomitant is discoverable, the inference may be accepted.

[29] See "Costs of Production in the Sugar Industry," pp. 16–20.

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Subject Index

to

Tariff Information Surveys and Reports

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Abbreviations:
Ms.—Manuscript (typewritten).
FL—Free List.
*—Printed edition exhausted.
N. S. P. F.—not specially provided for.

Subject.	Status.	Tariff act of 1913.	
		Schedule.	Paragraph.
Abrasive garnet (see Abrasives)	Ms	N. S. P. F.	.....
Abrasives	Ms	B, N, FL	.....
Acetanilid	Ms	A	18
Acetic anhydrid	Ms	A	2
Acetic or pyroligneous acid	Ms	FL	387
Acetone and acetone oil	Ms	A	3
Acetphenetidin	Ms	A	18
Acetylamidobenzene (see Acetanilid)	Ms	A	18
Acetylsalicylic acid, or aspirin	Ms	A	18
Acids:			
Acetic or pyroligneous	Ms	FL	387
Acetylsalicylic	Ms	A	18
Arsenic or arsenious	Ms	FL	387
Boracic	Printed	A	1
Carbolic (act Sept. 8, 1916)	In progress	.....	.....
Chromic	Ms	FL	387
Citric	Printed	A	1
Fluoric	Ms	FL	387
Formic	Printed	A	1
Gallic	Printed	A	1
Glycerophosphoric	Ms	A	18
Hydrochloric or muriatic	Ms	FL	387
Hydrofluoric	Ms	FL	387
Muriatic or hydrochloric	Ms	FL	387
Nitric	Ms	FL	387
Phosphoric	Ms	FL	387
Pyrogallic	Printed	A	1
Salicylic (act Sept. 8, 1916)	Ms	.....	.....
Silicic	Ms	FL	387
Sulphuric, or oil of vitriol	Ms	FL	387
Tannic	Ms	A	1
Tartaric	Printed	A	1
Acids of Paragraph 1 and Related Materials (No. 13, Tariff Information Series).	Printed	A	1
Acid sodium carbonate or bicarbonate of soda	Ms	A	67
Aconite	Ms	FL	388
Adhesive sheathing felt	Ms	FL	481
Agar-agar	Ms	A	34
Agricultural—			
Implements	Ms	FL	391
Tractors	Ms	FL	391
Albata (see Argentine, etc.)	Ms	C	145
Albumen, n. s. p. f.	Ms	FL	392
Alder bark	In progress	N. S. P. F.	.....
Alizarin (act Sept. 8, 1916)	do	.....	.....
Alizarin assistant	Ms	A	45
Althea root	Ms	FL	544
Alum:			
Cake	Ms	A	6
Patent	Ms	A	6
Aluminum:			
Alloys	Ms	C	143
Bars	Ms	C	143
Compounds	Ms	A	6
Hydrate of	Ms	A	6
Leaf	Ms	C	146
Manufactures of	Ms	C	114, 134, 143, 146
Plates	Ms	C	143
Rods	Ms	C	143
Scrap	Ms	C	143
Sheets	Ms	C	143
Strips	Ms	C	143
Sulphate of	Ms	A	6
Utensils	Ms	C	134

Subject.	Status.	Tariff Act of 1913.	
		Schedule.	Paragraph.
Aluminous cake	Ms	A	6
Amber and amberoid, crude (see Gums)	Ms	A	36
Ambergris	In progress	A	49
Ammonia compounds:			
Ammonium picrate	Ms	N. S. P. F.	
Ammoniacal gas liquor	Ms	A	7
Ammonium nitrate	Ms	FL	395
Ammonium citrate (see Citric acid, etc.)	Ms		
Aqua ammonia	Ms	N. S. P. F.	
Carbonate of ammonia	Ms	A	7
Liquid anhydrous ammonia	Ms	A	7
Muriate of ammonia	Ms	A	7
Perchlorate of ammonia	Ms	FL	395
Phosphate of ammonia	Ms	A	7
Sal ammoniac	Ms	A	7
Sulphate of ammonia	Ms	FL	395
Ammoniac, gum resin	In progress	N. S. P. F.	
Amylic alcohol or fusel oil	Ms	A	33
Amyl nitrite and amyl acetate (see Ethers and esters)	Ms	A	29
Anaesthetics (see Chloroform and Ethyl chloride)	Ms	A	
Angostura bark	In progress		
Anilin oil and salts (act Sept. 8, 1916)	In progress		
Anise or anise seed oil (see Oils, distilled and essential)	do	A	46
Annatto and annatto extract	Ms	FL	399
Annual reports:			
First	Printed*		
Second	Printed		
Third	do		
Antifriction balls and bearings	Ms	C	106
Anthracite coal	Ms	FL	451
Antimonial lead (type metal)	Ms	C and FL	160, 637
Antimony, ore, matte, regulus, metal	Ms	C and FL	144, 396
Antimony potassium tartrate, or tartar emetic (see Argols or Crude tartar).	Ms	N. S. P. F.	
Archil and cudbear	Ms	FL	469, 564
Areca nuts	In progress	A	27
Argentine, albata, or German silver	Ms	C	145
Argols or crude tartar—wine lees, cream of tartar, tartaric acid, and Rochelle salts.	Ms	A	1, 8
Arnica, flowers, leaves, roots	In progress	N. S. P. F.	
Arrowroot	do	FL	402
Arsenate of soda	Ms	FL	605
Arsenic and arsenious acid	Ms	FL	387, 403
Art, works of	Ms	FL	654
Artificial flowers and feathers	In progress	N	347
Artificial silk	do	L	319
Artists' paints or colors	do	A	63
Asafetida	Ms	FL	405
Asbestos:			
Manufactures of	Ms	N	367
Packing	Ms	N	367
Textiles	Ms	N	367
Unmanufactured	Ms	FL	406
Aspirin (see Acetylsalicylic acid)	Ms	A	18
Automobiles and parts	Ms	C	119
Axes	Ms	N. S. P. F.	
Axles, iron and steel	Ms	N. S. P. F.	
Bagatelle balls (see Dice, Dominoes, Draughts, Chessmen, Chess balls, Billiard and pool balls, and Poker chips).	Ms	N	341
Bagging, cotton, or gunny (see Jute)	In progress	J	408
Bags or sacks, burlap (see Jute)	do	J	281
Baking soda (see Sodium bicarbonate)	Ms	A	67
Balls and bearings, antifriction	Ms	C	106
Balls, chess and bagatelle	Ms	N	341
Balm of Gilead	Ms	FL	409
Bandings, beltings, etc.:			
Cotton (see Cotton small wares)	In progress	I	263
Flax, hemp, or ramie	do	J	278
Silk	do	L	316
Barbed wire (see Iron and steel)	Ms	FL	645
Balsams:			
Canada	Ms	A	9
Copaiba	Ms	A	9
Peru	Ms	A	9
Tolu	Ms	A	9
Band steel:			
Cut to lengths	Ms	FL	509
N. s. p. f.	Ms	C	107
Partly manufactured	Ms	FL	509
Bar iron	Ms	C	103

Subject.	Status.	Tariff act of 1913.	
		Schedule.	Paragraph.
Bargaining tariffs and commercial treaties of European States: Special attention to— France, Germany, Russia (see Reciprocity and Commercial Treaties)	Printed		
Barite—also called "barytes" (barium sulphate), "heavy spar," and "tiff" (see Barium compounds).	Ms	A	
Barium:			
Binoxide			
Carbonate			
Chlorate			
Chloride			
Chromate or lemon yellow or yellow ultramarine			
Compounds			
Dioxide			
Hydroxide, hydrate of baryta or caustic baryta	Ms	A	5, 10, 51, 61, 646
Lithopone			
Monoxide or baryta			
Nitrate			
Peroxide			
Sulphate			
Sulphide			
Witherite			
Barley (see report on Agricultural Trade with Canada)	Ms	G	188
Bar woods (see Red woods)	Ms	A	
Barytes or barium sulphate	Ms	A	51
Base bullion	Ms	C	153
Baskets	Ms	D	175
Batting, cotton	In progress	I	264
Bauxite	Ms	FL	411
Bayberry leaves	In progress	N. S. P. F.	
Beads and spangles	Ms	N	333
Beans and lentils	Ms	G	197
Bearings and balls, antifriction	Ms	C	106
Belladonna, leaves and roots	Ms	A and FL.	27, 477
Belgium (see Colonial Tariff Policies)	In progress		
Bell metal, broken	Ms	FL	413
Bells, broken	Ms	FL	413
Belting for machinery, cotton	In progress	I	262
Benzoate of soda	do	A	67
Benzoic acid (act Sept. 8, 1916)	do		
Benzoin, gum	do	A	27
Bergamot oil	do	A	46
Berlin blues	Ms	A	52
Biborate of soda or borax	Ms	A	67
Bicarbonate of soda or acid sodium carbonate (see Sodium bicarbonate).	Ms	A	67
Bichloride of tin or stannous chloride	Ms	A	65
Bichromate of potash (see Chromium compounds)	Ms	A	64
Bichromate of soda	Ms	A	67
Billiard balls	Ms	N	341
Binding twine	In progress	FL	415
Birch tar oil	In progress	FL	561
Bismuth	Ms	FL	418
Bismuth citrate (see Citric acid and Citrate of lime)	Ms	N. S. P. F.	
Bituminous coal (see Coal)	Ms	FL	451
Black pigments, bone, ivory, or vegetable	Ms	A	53
Blackberry leaves	In progress	N. S. P. F.	
Blackhaw bark	do	N. S. P. F.	
"Black strap" (see Molasses)	Ms	E	177
Blanc fixe (artificial sulphate of barytes)	Ms	A	51
Blankets, wool	Ms	K	289
Blankets and quilts, cotton	In progress	I	264
Bleaching powder	Ms	A	12
Blood char	Ms	FL	447
Blooms and slabs, iron and steel	Ms	C	110
Blown and pressed ware, glass	Ms	B	84
Blue vitriol and verdigris	Ms	FL	421
Blues, Berlin	Ms	A	52
Bolting cloth, silk	Ms	FL	422
Bones, bone dust, meal, and ash	In progress	FL	423
Bone char	Ms	FL	447
Boots and shoes (see Leather)	Ms	FL	530
Boracic acid and borax	Ms	A	1, 67
Boracite, borate of magnesia (see Boracic acid)	Ms	N. S. P. F.	
Borate of lime, colemanite (see Boracic acid)	Ms	FL	429
Borate of magnesia, boracite (see Boracic acid)	Ms	N. S. P. F.	
Borax and boracic acid	Ms	A	1, 67
Boric acid, boracic acid	Ms	A	1
Bort and diamond dust	In progress	N	357
Bottle caps	Ms	C	164

Subject.	Status.	Tariff act of 1913.	
		Schedule.	Paragraph.
Bottles, glass	Ms	B	83
Brads, tacks, and staples	Ms	FL	654
Brazilwood (see Red woods)	Ms	N. S. P. F.	
Briar root and briar wood, ivy and laurel root	Ms	D	168
Brimstone or sulphur	Ms	FL	617
Bristles	Ms	N and FL.	337, 432
British Empire (see Colonial Tariff Policies)	In progress		
British gum (see Dextrine)	Ms	A	36
British Wool Manufacturing Industries, Survey of	Printed		
Bromin, bromine	Ms	FL	423
Bronze powders, flitters, and metallics	MS	C	146
Broom root	In progress	FL	497
Brooms	do	N	336
Brush Industry, The (No. 8, Tariff Information Series)	Printed*		
Brushes	Ms	N	336
Brushes, plates, disks, and miscellaneous manufactures of carbon (for electrical purposes).	In progress	B	81
Buchu leaves	Ms	A	39
Buckles, hooks and eyes, snap fasteners	Ms	C	151, 167
Buckthorn bark	In progress	N. S. P. F.	
Burgundy pitch	do	FL	437
Burlaps (see Jute)	do	J and F. L.	279, 408
Burrstones (see Abrasives)	Ms	FL	438, 614
Butter and substitutes for	Ms	G	195
Button Industry, The (No. 4, Tariff Information Series)	Printed*		
Buttons	Ms	C and N	151, 339, 356
Cables and cordage, hemp, etc.	Ms	J	268
Cables, metal and rubber	Ms	C	114
Cadmium	Ms	FL	439
Caffein and compounds of caffein	Ms	A	13
Caffein citrate (see Citric acid)	Ms	N. S. P. F.	
Calabar beans	In progress	N. S. P. F.	
Calamine	Ms	C	162
Calcium:			
Acetate (see Hardwood distillation industry)	Ms	FL	440
Carbide	Ms	FL	440
Chloride	Ms	FL	440
Citrate (see Citrate of lime)	Ms	A	41
Cyanamid, or lime nitrogen	Ms	FL	499
Nitrate (see Nitrates of soda, calcium, etc.)	Ms	FL	440
Oxalate (see Oxalic acid)	Ms	N. S. P. F.	
Calendula flowers	In progress	N. S. P. F.	
Calomel (see Mercurial preparations)	Ms	A	14
Cam wood (see Red woods)	Ms	N. S. P. F.	
Cameras (see Photographic plates, etc.)	Ms	N	
Camphor, crude, refined, and synthetic	Ms	A	36
Canada:			
(see report on Agricultural Trade with)	Ms		
(see Colonial Tariff Policies)	In progress		
(see report on Reciprocity with)	Ms		
(see Wool-growing industry)	Ms		
Canella	In progress	N. S. P. F.	
Canes and umbrellas	do	N	383
Cannabis	Ms	N. S. P. F.	
Canned or prepared beans, peas, mushrooms, etc.	Ms	G	199
Cantharides	Ms	N. S. P. F.	
Caraway	In progress	A	46
Carbides of silicon (see Abrasives)	Ms	N. S. P. F.	
Carbon electrodes	In progress	C	81
Carbon manufactures	do	C	81, 82
Carbon tetrachloride	Ms	A	19
Carbons for electric lighting	In progress	C	82
Card laps, cotton	Ms	I	250
Cardamom seed	Ms	FL	595
Carpets, carpeting, mats, rugs, etc.:			
Cotton	In progress	K	302
Vegetable fiber, except cotton	do	J	273
Wool	do	K	
Caseara sagrada, bark	do	N. S. P. F.	
Cascarilla	do	N. S. P. F.	
Cassia oil	do	A	46
Castor or castoreum	Ms	FL	442
Castor oil and alizarin assistants (castor beans or seeds and castor-bean pomace).	Ms	A, G, and FL.	45, 212, 560
Catgut	Ms	N and FL.	366, 443
Caustic baryta, barium hydroxide, or hydrate of baryta (see Barium compounds).	Ms	N. S. P. F.	
Caustic soda	Ms	A	67
Cedrat oil	In progress	A	46

Subject.	Status.	Tariff act of 1913.	
		Schedule.	Paragraph.
Celluloid (see Pyroxylin plastics)	Ms	A	25
Cellulose esters (see Pyroxylin plastics)	Ms	A	25
Census of Dyes and Coal-Tar Chemicals, 1917 (No. 6, Tariff Information Series).	Printed *	.....	.....
Census of Dyes and Coal-Tar Chemicals, 1918 (No. 11, Tariff Information Series).	Printed	.....	.....
Cerite (see Incandescent gas mantles)	Ms	FL	445
Cerium metal (see Incandescent gas mantles)	Ms	FL	445
Cerium nitrates (see Incandescent gas mantles)	Ms	N. S. P. F.	.....
Chains, iron or steel	Ms	C	126
Chains, machine	Ms	C	126
Chalk	Ms	A and FL.	15, 446
Chamois skins	In progress	N	359
Chamomile flowers	Ms	N. S. P. F.	.....
Charcoal (see Hardwood distillation industry)	Ms	FL	447
Chenilles (see Silk pile fabrics)	Ms	L	.....
Chess balls	In progress	N	341
Chessmen	do	N	341
Chicle	do	A	36
China: Tariff (History and System)	Ms	.....	.....
Chinaware	Ms	B	80
Chinese Industries	Ms	.....	.....
Chinese nut oil and other nut oils	In progress	FL	561
Chloral hydrate	Ms	A	18
Chlorate of soda	Ms	A	67
Chloride of:			
Lime, or bleaching powder	Ms	A	12
Sulphur	Ms	N. S. P. F.	.....
Tin	Ms	N. S. P. F.	.....
Zinc	Ms	A	62
Chlorine and liquid chlorine	Ms	N. S. P. F.	.....
Chloroform	Ms	A	19
Chlorophyll extract	Ms	A	31
Chromate of:			
Iron, or chromic ore	Ms	FL	448
Potash (see Chromium compounds)	Ms	A	64
Soda (see Chromium compounds)	Ms	A	67
Chrome or chromium metal—ferrochrome or ferrochromium	Ms	C	102
Chrome acetate (see Chromium compounds)	Ms	N. S. P. F.	.....
Chrome alum (see Chromium compounds)	Ms	N. S. P. F.	.....
Chrome pigments—chrome yellow and green	In progress	A	54
Chromic acid (see Chromium compounds)	Ms	A	387
Chromic ore, or chromate of iron	Ms	FL	448
Chromium compounds:			
Chromates and bichromates of—			
Potash			
Soda			
Chromic acid	Ms	A and FL.	64, 67, 387, 449
Chromium hydroxide			
Chrome acetate			
Chrome alum			
Chromium metal	Ms	C	102
Chrysarobin	In progress	N. S. P. F.	.....
Cinchona or other quinine barks	do	FL	410
Cinnamon oil	do	A	46
Cinnamon and cinnamon chips	do	G	235
Citrate of lime and citric acid	Printed	A	1, 41
Citrate of lime, or calcium citrate	do	A	41
Citric acid and citrate of lime	do	A	1, 41
Citronella and lemon grass oils	In progress	A	46
Citrus fruits	do	G	220
Civet	do	A	49
Clock jewels:			
Movements, lever	Ms	C	161
Movements, marking of	Ms	C	161
Clocks and parts thereof n. s. p. f.	Ms	C	161
Cloth:			
Cotton	Ms	I	252
Flax, hemp, or ramie	In progress	J	283
Wool	do	K	288
Coal	Ms	FL	451
Coal-tar explosives (act Sept. 8, 1916)	In progress	.....	.....
Cobalt (cobalt oxide, zaffre, and smalts)	Ms	C and FL.	24, 63, 453, 657
Coca leaves	Ms	A	39
Cocaine and cocaine salts	Ms	A	47
Cocculus indicus	Ms	FL	454
Cochineal	In progress	FL	455
Cocoa, or cacao, crude and filter, leaves and shells of	Ms	FL	456
Cocoa and chocolate	Ms	G	231
Cocoa butter and substitutes	Ms	G	232

Subject.	Status.	Tariff act of 1913.	
		Schedule.	Paragraph.
Cocoa and rattan mats and mattings	In progress	N	371
Coconut, shell, meat, shredded, oil	Ms	G and F L.	221, 232, 557, 561
Cocoons, silk	Ms	F L	599
Cod and cod liver oil	In progress	F L	561
Coffee	Ms	F L	457
Coir or cocoa fiber	In progress	F L	459
Mats and matting of	do	N	371
Yarns	do	F L	459
Collapsible tubes	do	C	164
Collars and cuffs:			
Cotton	Ms	I	256
Linen	Ms	J	277
Collodion (see Pyrox. lin plastics)	Ms	A	25
Colocynth, fruit	In progress	N. S. P. F.	
Colonial Tariff Policies:			
Belgium	do		
British Empire–			
Crown Colonies and India	do		
Self-governin : Dominions	do		
Australia	do		
New Zealand	do		
Union of South Africa	do		
Canada	do		
Newfoundland	do		
France	do		
Germany	do		
Italy	do		
Japan	do		
Portugal	do		
Spain	do		
The Netherlands	do		
United States	do		
Commercial Treaties of the World, Digest of	do		
Commercial treaties (see Reciprocity and Commercial Treaties)	Printed		
Color lakes (act Sept. 8, 1916)	In progress		
Coloring for liquors	Ms	A	26
Columns and posts, iron or steel	Ms	C	104
Composition metal leaf	Ms	C	146
Conduranzo	In progress	N. S. P. F.	
Confectionery	do	E	180
Copaiba (see Balsams)	Ms	A	9
Copal, damar and kauri	In progress	F L	500
Copper acetate (see Blue vitriol and verdigris)	Ms	F L	421
Copper:			
Alloys, rolling mill products, sheets, rods, wire, castings	Ms	C	114, 147
Unmanufactured	Ms	F L	461
Bottoms	Ms	C	147
Braziers'	Ms	C	147
Cement (see Copper ore, etc.)	Ms	F L	461
Metal, crude, refined, and old	Ms	F L	461
Ore, matte, regulus	Ms	F L	461
Pipes	Ms	C	147
Plates	Ms	C	147
Rods	Ms	C	147
Rolling and wire mill products	Ms	C	114, 147
Scale	Ms	F L	461
Sheathing	Ms	C	147
Sheets	Ms	C	147
Strips	Ms	C	147
Sulphate (see Blue vitriol)	Ms	F L	421
Tubes	Ms	N. S. P. F.	
Wire	Ms	N. S. P. F.	
Copperas or sulphate of iron	Ms	F L	462
Copra	Ms	G	557
Cordage and cables	Ms	J	278
Cork	Ms	N	340
Corn oil	Ms	N. S. P. F.	
Corrosive sublimate (see Mercurial preparations)	Ms	A	14
Corsets, cotton, made in part of lace, etc	In progress	N	357
Corundum (see Abrasives):			
Manufactures of	Ms	N	343
N. s. p. f.	Ms	F L	479
Cosmetics and perfumery (see also act of Oct. 3, 1917, providing additional duty on alcoholic content of perfumes).	In progress	A	48
Costs of Production in the Sugar Industry (No. 9, Tariff Information Series).	Printed		
Costs of Production of Dyes, 1918–19 (No. 15, Tariff Information Series).	do		
Cotton bagging, jute	In progress	F L	406

Subject.	Status.	Tariff act of 1913.	
		Schedule.	Paragraph.
Cotton:			
Bath mats	In progress	I	264
Batting	do	I	264
Belting, for machinery	do	I	262
Blankets and quilts	do	I	264
Card laps, sliver, and roving	Ms	I	250
Carpets and mats	In progress	K	302
Chenille goods	Ms	I	258
Cloth	Ms	I	252
Tracing	Ms	I	254
Waterproof	Ms	I	254
Clothing, ready-made	Ms	I	256
Collars and cuffs	Ms	I	256
Corsets	Ms	I	256
Crochet, darning, and embroidery	Ms	I	250
Curtains—			
Chenille	Ms	I	258
Lace	In progress	N	358
Nottingham lace	do	I	265
Embroideries, laces, etc	do	N	358
Gloves	do	I	260
Handkerchiefs and mufflers—			
Embroidered	do	N	358
Not ornamented	do	I	255
Hosiery	do	I	259, 260
Jacquard figured goods	Ms	I	258
Knit goods	In progress	I	259, 261
Laces and articles made thereof	do	N	358
Linters	Ms	FL	467
Manufactures, n. s. p. f.	In progress	I	266
Mop rags	do	I	264
Nottingham lace curtains	do	I	265
Oilcloth	Ms	I	254
Pile fabrics	Ms	I	257
Pillow cases	In progress	I	264
Polishing cloths	do	I	264
Raw	Ms	FL	467
Sewing thread	Ms	I	250
Sheets	In progress	I	264
Small wares	do	I	262
Table damask	do	I	263
Towels	do	I	264
Tracing cloth	Ms	I	254
Underwear	In progress	I	261
Wash cloths	do	I	264
Waste	Ms	FL	467
Waterproof cloth	Ms	I	254
Wearing apparel	In progress	I	255
Knit	do	I	261
Lace	do	N	358
Ready-made	Ms	I	256
Yarn	Ms	I	250
Cotton Venetians: Import Trade and Domestic Production (No. 10, Tariff Information Series).	Printed		
Cotton Yarn: Import and Export Trade in Relation to the Tariff (No. 12, Tariff Information Series).	do		
Cotton-and-silk cloths	Ms	I	254
Cotton and silk industries, Recent developments in the Japanese	In progress		
Crayons and fusains	do	A	63
Cream of tartar (see Argols and crude tartar)	Ms	A	8
Cream separators	Ms	FL	441
Crin vegetal	In progress	FL	497
Crucible steel	Ms	C	110
Crude steel	Ms	FL	613
Cryolite, or kryolith	Ms	FL	468
Cudbear	Ms	FL	469
Cultivators (see Agricultural implements)	Ms	FL	391
Curtains and articles made on Nottingham lace-curtain machine	In progress	I	265
Cutlery (see Knives)	Ms	C	130
Cut nails and spikes	Ms	FL	554
Cyanamid, or cyanimide	Ms	FL	499
Cyanides of potash and soda	Ms	FL	580, 605
Dandelion root:			
Ground	In progress	G	233
Unground	Ms	FL	473
Decanters, glass, n. s. p. f.	Ms	B	84
Demijohns, glass	Ms	B	83
Dental instruments	In progress	N. S. P. F.	
Desiccated potatoes (see Potato products)	Printed	FL	581

Subject.	Status.	Tariff act of 1913.	
		Schedule.	Paragraph.
Dextrine and British gum	Ms	A	36
Potato (see Potato products)	Printed	A	36
Dials, watch and other instruments, enameled	Ms	C	161
Diamond dust and bort (see Abrasives)	Ms	N	357
Diatomaceous earth (see Abrasives)	Ms	N. S. P. F.	
Dice (see Dominoes, Poker chips, etc.)	In progress	N	341
Digest of Commercial Treaties of the World	do		
Disk harrows (see Agricultural implements)	Ms	FL	391
Distilled and essential oils	In progress	A	46
Dogwood, Jamaica	do	N. S. P. F.	
Dolls and toys	do	N	342
Domestic Potato-Products Industry, The	Printed		
Dominoes (see Dice, Poker chips, etc.)	In progress	N	341
Draftmen's instruments	Ms	N. S. P. F.	
Draughts (see Dice, Poker chips, etc.)	In progress	N	341
Dress goods, woolen	do	K	290
Dried blood	do	FL	420
Dried eggs and egg products	do	G	204
Dried potatoes (see Potato products)	Printed		
Drills, agricultural (see Agricultural implements)	Ms	FL	391
Dross lead	Ms	C	153
Dumping and Unfair Competition	Printed		
Dyes (act Sept. 8, 1916; see Report on Dye-stuff Situation in the Textile Industries; Census of Dyes and Coal-tar Chemicals, 1917; Census of Dyes and Coal-tar Chemicals, 1918; Cost of Production of Dyes, 1918–19; Dyes and Related Coal-tar Chemicals.)	do		
Dyes and other Coal-Tar Chemicals	do		
Dyestuff Situation in the Textile Industry (No. 2, Tariff Information Series).	Printed*		
Dyes and Related Coal-Tar Chemicals	Printed		
Dynamite (see Explosives)	Ms	FL	501
Earthenware, common yellow, brown, or gray	Ms	B	78
Earthenware, Rockingham	Ms	B	78
Ecgonine (cocaine) and derivatives	Ms	A	47
Eggs, dried, and egg products	In progress	G	204
Eggs, frozen, and egg products	do	G	203
Elm bark	do	N. S. P. F.	
Emery (see Abrasives)	Ms	N and FL	343, 479
Enamel paints	In progress	A	63
Enamel ware	do	C	125, 134
Enameled upholstery leather	do	N	359
Enfleurage greases and floral essences	do	A	49
Epsom salts (see Magnesium compounds)	do	A	42
Ergot	Ms	A	28
Ethers and esters	Ms	A	29
Ethyl acetate and ethyl chloride (see Ethers and esters)	Ms	A	29
Eucalyptol	In progress	N. S. P. F.	
Eucalyptus oil (see Oils, distilled and essential)	do	N. S. P. F.	
Explosives	Ms	FL	501
Extracts and decoctions of nutgalls	Ms	A	30
Fabrics, woven silk	Ms	L	318
Fans	Ms	N	349
Farm wagons	Ms	C and FL	167, 391
Feathers and flowers	In progress	N	347
Felt, adhesive	do	FL	481
Fencing, woven wire, and poultry netting	Ms	FL	645
Fennel	In progress	A	46
Ferro alloys, minor:			
Ferro—			
Aluminum	Ms	C	102
Boron	Ms	C	102
Cerium	Ms	C	102
Phosphorus	Ms	C	102
Uranium	Ms	C	102
Zirconium	Ms	C	102
Ferrochrome (see Chrome, etc.)	Ms	C	102
Ferrochromium	Ms	C	102
Ferrocyanides and ferricyanides of potash and soda	Ms	N. S. P. F.	
Ferro-ferri-cyanide blues	In progress	A	52
Ferromanganese and spiegeleisen	Ms	FL	518
Ferromolybdenum (see Molybdenum)	Ms	C	102
Ferrotitanium (see Titanium)	Ms	C	102
Ferrotungsten	Ms	C	102
Ferrovanadium	Ms	C	102
Files	Ms	C	131
Filled and coated cloths	Ms	I	254
Films (see Photographic goods)	Ms	N and FL	380, 576
Filter masse	Ms	M	321

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		Schedule.	Paragraph.
Fir or Canada balsam (see Balsams)	Ms	A	9
Firearms	In progress	C	133
Fire extinguishers (see Carbon tetrachloride)	Ms	A	.....
Fireworks	In progress	N	344
First annual report	Printed *	.....	.....
Fish	In progress	G	216
Fish sounds	do	A and FL	34,419
Flavoring extracts	do	A	49
Flavors (act Sept. 8, 1916)	do	.....	.....
Flax (see also Linen)	Ms	FL	485
Gill netting, nets, etc	In progress	J	270
Measuring tapes	do	J	275
Threads, twines, etc	do	J	269
Yarns	Ms	J	270
Flax, hemp, and ramie yarns	Ms	J	270
Flaxseed (see report on Agricultural Trade with Canada)	Ms	G	212
Flaxseed and linseed oil (see Oils, expressed)	Ms	A	45
Flints and flintstones (see Abrasives)	Ms	B	.....
Floss, silk	Ms	L	313
Flour:			
Potato (see The Domestic Potato-Products Industry)	Printed	FL	581
Wheat	Ms	FL	644
Flowers, chamomile	Ms	N. S. P. F.	.....
Flowers and feathers	In progress	N	347
Fluoric acid	Ms	FL	387
Fluorite, or fluorspar	Ms	B	76
Forged spikes	Ms	FL	554
Formaldehyde solution, or formalin	Ms	A	32
Formic acid (see Acids of par. 1, etc.)	Printed	A	1
France (see Colonial Tariff Policies)	In progress	.....	.....
Free zones in Ports of the United States	Printed	.....	.....
French chalk (see Talc), advanced in value	Ms	A	69
Crude	Ms	FL	621
Frozen eggs and egg products	In progress	G	203
Fuller's earth	do	B	76
Fulminates	Ms	FL	490
Fulminating powder	Ms	FL	490
Furs:			
Dressed, and manufactures of	In progress	N	348
Undressed	do	FL	491
Fur-felt hats	do	N	354
Fusel oil, or amylic alcohol	Ms	A	33
Fustic	In progress	N. S. P. F.	.....
Galena (see Lead ore)	Ms	N. S. P. F.	.....
Gallic acid (see Tannic acid, Acids of par. 1)	Printed	A	1
Gambier, cutch, mangrove, and kino (including terra japonica, par 630)	In progress	N. S. P. F.	.....
Gamboge	do	N. S. P. F.	.....
Garnet, abrasive (see Abrasives)	Ms	FL	479
Gas and lamp black	In progress	A	53
Gas mantles (No. 14, Tariff Information Series)	Printed	C	154
Gas-mantle scrap (see Gas mantles)	Printed	C	154
Gelatin, glue, glue size, isinglass and prepared fish sounds, agar-agar	In progress	A	34
Gentian	Ms	A	39
Germany (see Colonial Tariff Policies)	In progress	.....	.....
Gill nettings	do	J	271
Glass:			
Blown ware	Ms	B	84
Bottles	Ms	B	83
Cast, polished, plate, unsilvered	Ms	B	88
Decanters	Ms	B	84
Demijohns	Ms	B	83
Industry as Affected by the War (No. 5, Tariff Information Series)	Printed *	.....	.....
Optical and Chemical Glassware	Printed	.....	.....
Pressed ware	Ms	B	84
Glauber's salt, sodium sulphate	Ms	A	67
Glazes, fluxes, enamels, and colors, ceramic and glass	In progress	A	63
Glove leather	In progress	N	359
Gloves:			
Cotton	Ms	I	260
Leather	Ms	N and FL	361, 362, 363, 364, 495
Glucose (see Molasses)	Ms	E	178
Glue:			
Size	Ms	A	34
Stock	Ms	FL	504

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		Schedule.	Paragraph.
Glycerin	Ms	A	35
Glycerophosphoric acid and salts and compounds thereof	Ms	A	18
Gold leaf	Ms	C	148
Graphite	Printed	FL	579
Grindstones (see Abrasives; see also pars. 438 and 614 Free List)	Ms	B	100
Grit, shot and sand made of iron or steel (see Abrasives)	Ms	C	112
Guano and basic slag	In progress	FL	499
Guarana	do	N. S. P. F.	.....
Guaiac	do	A	27
Guaiacol, compounds and preparations of	do	A	18
Gum:			
Amber and amberoid	do	A and FL	36,500
Arabic or Senegal	do	A	36
Camphor	do	A	36
Chicle	do	A	36
Dextrine or British gum	Ms	A	36
Hair:			
Alpaca	In progress	K	305
Angora goat	do	K	305
Camels	do	FL	650
Curled, for beds, etc	do	N	352
Human	do	N	351
Haircloth	do	N	353
Handkerchiefs:			
Cotton	do	I	255
Cotton, made in part of lace	do	N	358
Linen	do	J	282
Silk	do	L	315
Hardwood distillation industry	Ms	FL	393,440 / 447,626
Hat braids and manufactures of, ramie	In progress	N	334
Hatter's plush	Ms	N	382
Harvesters (see Agricultural implements)	Ms	FL	391
Hay (see report on Agricultural Trade with Canada)	Ms	G	205
Headers (see Agricultural implements)	Ms	FL	391
Healing plasters and court plaster	Ms	A	50
Heavy spar (see Barium compounds)	Ms	N. S. P. F.	.....
Hemp	Ms	FL	485
Hempseed	Ms	FL	595
Hempseed oil	Ms	A	45
Hide rope	Ms	FL	505
Hides of cattle, raw	In progress	FL	506
Hones (see Abrasives)	Ms	FL	507
Hoofs, unmanufactured	do	FL	508
Hooks and eyes, buckles, snap fasteners	Ms	C	151,167
Horse, mule and ox shoes	Ms	FL	554
Horseshoe nails	Ms	FL	554
Horns, unmanufactured	In progress	FL	511
Hose, hydraulic or flume	Ms	J	274
Hospital utensils	Ms	C	134
Human hair	In progress	N	351
Hydrate of baryta, barium hydroxide or caustic baryta (see Barium compounds).	Ms	N. S. P. F.	.....
Hydraulic or flume hose	Ms	J	274
Hydrochloric or muriatic acid	Ms	FL	387
Hydrofluoric acid	Ms	FL	387
Hydrosulphite of soda	Ms	N. S. P. F.	.....
Hyoscyamus, leaves	In progress	A	27
Hyposulphite of soda	Ms	A	67
Iceland moss	In progress	N. S. P. F.	.....
Ichthyol	do	FL	561
Imitation pearls (see Beads and spangles)	Ms	N	333
Incandescent Gas Mantles (No. 14, Tariff Information Series)	Printed	C	154
Indian red, and oxides of iron	In progress	A	55
Indigo (act Sept. 8, 1916)	do	.....	.....
Ink and ink powders	do	A	37
Instruments:			
Dental	do	N. S. P. F.	.....
Draftmen's	Ms	N. S. P. F.	.....
Surgical (see Surgical Instrument Industry, No. 7, Tariff Information Series).	Printed	N. S. P. F.	.....
Interim Legislation	Printed*	.....	.....
Ingots:			
Nickel	Ms	C	155
Steel, cogged, rolled, hammered, etc	Ms	C and FL	110,613
Steel, rolled, hammered, etc	Ms	C	110
Iodine	In progress	FL	515
Iodine compounds	do	A	5,38

Subject.	Status.	Tariff act of 1913.	
		Schedule.	Paragraph.
Iodide of potassium (see Iodine compounds)	Ms	A	38
Iodoform and potassium iodide (see Iodine compounds)	Ms	A	38
Ipecac	Ms	FL	516
Iridium and osmiridium	Ms	FL	517
Iron:			
Blooms	Ms	FL	518
Chromate of	Ms	FL	448
In pigs	Ms	FL	518
Kentledge	Ms	FL	518
Loops	Ms	FL	518
Ore	Ms	FL	518
Ore, manganiferous	Ms	FL	518
Oxide of (see Pigments)	Ms	A	.....
Slabs	Ms	FL	518
Sulphate of	Ms	FL	462
Sulphuret of	Ms	FL	617
Iron and steel:			
Air rifles	In progress.	C	132
Angles	Ms	C	104
Antifriction balls	Ms	C	106
Anvils	In progress.	C	118
Axle bars	Ms	C	121
Axle blanks	Ms	C	121
Axles and parts	Ms	C	121
Ball bearings	Ms	C	106
Band—			
Cut to lengths	Ms	FL	509
Partly manufactured	Ms	FL	509
Barbed wire	Ms	FL	645
Beams	Ms	C	104
Bicycles and parts	In progress.	C	120
Billets	Ms	FL	613
Blades, knife, etc	Ms	C	128
Blooms	Ms	FL	613
Boiler	In progress.	C	105
Bolts	do	C	123
Brads	Ms	FL	554
Buckles	In progress.	C	151
Budding knives	Ms	C	128
Building forms	Ms	C	104
Bulb beams	Ms	C	104
Car-truck channels	Ms	C	104
Card clothing	In progress.	C	124
Castings	Ms	C and FL	125,613
Chain or chains	Ms	C	126
Channels	Ms	C	104
Clasp knives	Ms	C	128
Columns and posts	Ms	C	104
Corset—			
Clasps	In progress.	C	114
Steels	do	C	114
Cut—			
Nails	Ms	FL	554
Spikes	Ms	FL	554
Deck beams	Ms	C	104
Dress steels	In progress.	C	114
Fasteners, snap	Ms	C	151
Frames	Ms	C	104
Girders	Ms	C	104
Hinges	In progress.	C	123
Hobnails	Ms	FL	554
Hoop—			
Cut to lengths	Ms	FL	509
Partly manufactured	Ms	FL	509
Horseshoe:			
Nails	Ms	FL	554
Nail rods	Ms	FL	554
Horseshoes	Ms	FL	554
Ingots	Ms	FL	613
Joists	Ms	C	104
Manicure knives	Ms	C	128
Motor cycles and parts	In progress.	C	120
Mule shoes	Ms	FL	554
Muskets	In progress.	C	132
Nail rods	Ms	C	113
Nuts	In progress.	C	123
Ox shoes	Ms	FL	554
Penknives	Ms	C	128
Pistols	In progress.	C	133
Pocket knives	Ms		128

Subject.	Status.	Tariff act of 1913.	
		Schedule.	Paragraph.
Iron and steel—Continued.			
Pruning knives	Ms	C	128
Railway—			
Bars	Ms	FL	587
Fish plates	In progress	C	108
Tires	Ms	C	142
Wheels	Ms	C	142
Razors	Ms	C	128
Rifles	In progress	C	132
Rivet rods	Ms	C	113
Roller bearings	Ms	C	106
Saws	Ms	C	139
Scissors	Ms	C	128
Screw rods, wire	Ms	C	113
Shears	Ms	C	128
Shotguns	In progress	C	132
Side arms	Ms	C	129
Slabs	Ms	FL	613
Spikes	Ms	FL	554
Structural	Ms	C	104
Sword blades	Ms	C	129
Swords	Ms	C	129
Tacks	Ms	FL	554
Taggers' tin	Ms	C	109
Terne plates	Ms	C	109
Tin plate, coated with metal	Ms	C	109
Tires, locomotive	Ms	C	142
Washers	In progress	C	123
Wire—			
Covered with cotton, silk, etc	Ms	C	114
Flat	In progress	C	114
Nails	Ms	FL	554
Rods—			
Cold rolled, etc	Ms	C	113
N. s. p. f	Ms	C	113
Round	Ms	C	114
Staples	Ms	FL	554
Isinglass	In progress	A	34
Istle or Tampico fiber	do	FL	497
Dressed, dyed, or combed	do	J	285
Italy (see Colonial Tariff Policies)	In progress	.....	.....
Ivy root, laurel root, briar root, and briar wood	Ms	D	168
Jacquard figured cotton:			
Manufactures of	In progress	I	256
Upholstery goods	do	I	256
Jalap	Ms	FL	519
Japan:			
Tariff (History and System)	Ms	.....	.....
Trade During the War	Printed	.....	.....
Japanese Cotton and Silk Industries, Recent developments in the	In progress	.....	.....
Japanese Industry before the War	Ms	.....	.....
Jasamine oil	In progress	A	46
Jewels, clock, watch, or meter	Ms	C	161
Juniper oil	In progress	A	46
Jute and jute butts	do	FL	497
Burlaps, not processed	do	FL	408
bleached, dyed, etc	do	J	279
Burlap bags and sacks	do	J	281
Cotton bagging of jute	do	J	408
Yarns	do	J	267
Kainite	Ms	FL	525
Kaolin	In progress	B	76
Kauri	Ms	FL	500
Kapoc	Ms	FL	497
Kelp	Ms	FL	523
Knives:			
Artists'	Ms	C	130
Bench	Ms	C	130
Bread	Ms	C	130
Budding	Ms	C	128
Butchers'	Ms	C	130
Butter	Ms	C	130
Carpenters'	Ms	C	130
Carving	Ms	C	130
Cheese	Ms	C	130
Clasp	Ms	C	128
Cooks'	Ms	C	130
Curriers'	Ms	C	130
Drawing	Ms	C	130

Subject.	Status.	Tariff act of 1913.	
		Schedule.	Paragraph.
Knives—Continued.			
Farriers'	Ms	C	130
Fleshing	Ms	C	130
Fruit	Ms	C	130
Hay	Ms	C	130
Hunting	Ms	C	130
Kitchen	Ms	C	130
Manicure	Ms	C	128
Painters'	Ms	C	130
Palette	Ms	C	130
Plumbers'	Ms	C	130
Pruning	Ms	C	128
Shoe	Ms	C	130
Table	Ms	C	130
Tanners'	Ms	C	130
Vegetable	Ms	C	130
Kohl-rabi seed	In progress.	G	212
Kryolith, or cryolite	Ms	FL	468
Kyanite, or cyanite, and kainite	Ms	FL	525
Laboratory glassware	Printed	B	95
Lac dye, crude, seed, button, stick, and shell	In progress.	FL	526
Laces, embroideries, etc., cotton	do	N	358
Lactarine and casein	Ms	FL	527
Lactart (see Lactic acid)	Printed	A	1
Lactic acid (see Acids of par. 1, etc.)	do	A	1
Lahn, or lame	Ms	C	150
Laurel root, ivy root, briar root, etc	Ms	D	168
Lead:			
Acetate of	Ms	A	57
Bullion	Ms	C	153
Compounds of, n. s. p. f	Ms	A	57
Dross	Ms	C	153
Manufactures of	Ms	C	153
Nitrate of	Ms	A	57
Ores	Ms	C	152
Oxides of (see Pigments), litharge, orange mineral, red lead	Ms	A	56
Pigs or bars	Ms	C	153
Scrap	Ms	C	153
Leather:			
Board	In progress.	FL	530
Compressed	do	FL	530
Cut	do	FL	530
Glove	Ms	N	359
Manufactures of	Ms	N	360
N. s. p. f	In progress.	FL	530
Lemon-grass and citronella oil	do	A	46
Lemon:			
Juice	Ms	FL	532
Oil	Ms	A	46
Peel	Ms	G and FL.	221, 563
Lemons (see Citrus fruits)	In progress.	G	220
Legislation, Interim	Printed		
Lentils, beans and	Ms	G	197
Lever clock movements	Ms	C	161
Licorice:			
Extracts of	Ms	A	40
Root	Ms	A	39
Lime:			
Borate of (see Boracic acid)	Printed	FL	429
Chloride of	Ms	A	12
Citrate of (see Citric acid)	Ms	A	41
Juice	In progress.	FL	532
Nitrogen (calcium cyanimid)	Ms	FL	499
Oil	In progress.	A	46
Limes (see Citrus fruits)	do	G	220
Linen:			
Collars and cuffs	do	J	277
Handkerchiefs	do	J	282
Hydraulic or flume hose	Ms	J	274
Pile fabrics	In progress.	J	280
Wearing apparel	do	J	278
Woven fabrics	do	J	283
All other manufactures of	do	J	284
Linoleum or oilcloth	do	J	276
Linters, cotton	Ms	FL	467
Liquid chlorine	Ms	N. S. P. F.	
Lithium citrate (see Citric acid)	[illegible]	N. S. P. F.	
Lithopone (see Barium compounds)	[illegible]	A	61
Litmus	[illegible]	FL	536
Locomotive tires, iron or steel	[illegible]	C	142

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		Schedule.	Paragraph.
Locomotives, steam	Ms	C	165
Logwood, extract	Ms	A	30
Logwood, crude	Ms	FL	477
London purple	Ms	FL	569
Lumber Industry, The	Ms	D	.....
Mace oil	In progress	A	46
Machine tools	Ms	C	165
Madder and extracts of	Ms	FL	538
Magnesite, crude and calcined	Ms	FL	539
Magnesite Industry, The	Printed	.....	.....
Magnesium and its alloys	Ms	C	143
Magnesium citrate (see Citric acid, etc.)	Printed	N. S. P. F.	.....
Magnesium compounds:			
Magnesia, calcined—			
Carbonate of, precipitated	In progress	A	42
Sulphate of	do	A	42
Manganese ore	Printed	.....	.....
Manganese, oxide and ore of	Ms	FL	540
Manila	In progress	FL	497
Cables and cordage	Ms	J	268
Manna	Ms	FL	541
Maple:			
Sirup	In progress	E	178
Sugar	do	E	178
Marshmallow or althea root	Ms	FL	544
Masks	Ms	N	370
Matches	Ms	N	345
Matte (see Copper ore, etc.)	Ms	C	.....
Mats or matting:			
Cocoa fiber	In progress	N	371
Straw or other vegetable substance	do	J	272
Vegetable fiber except cotton	do	J	273
Menthol	do	A	43
Mercurial preparations	Ms	A	14
Mercury or quicksilver (see Quicksilver)	Ms	C	.....
Millstones (see Abrasives)	Ms	FL	438
Mineral salts	Ms	FL	548
Minor ferro-alloys:			
Ferro—			
Aluminum	Ms	C	102
Boron	Ms	C	102
Cerium	Ms	C	102
Phosphorus	Ms	C	102
Uranium	Ms	C	102
Zirconium	Ms	C	102
Mohair	In progress	K	305
Molasses	Ms	E	177
Molybdenite	Ms	N. S. P. F.	.....
Molybdenum and ferromolybdenum	Ms	C	102
Molybdenum ores	Ms	N. S. P. F.	.....
Monazite sand (see Gas mantles)	Printed	C	154
Monohydrated sodium carbonate	Ms	A	67
Moss and seaweeds	In progress	N	372
Most-favored-nation clause in commercial treaties (see Reciprocity and Commercial Treaties).	Printed	.....	.....
Motion-picture films (see Photographic plates, etc.)	In progress	N	380
Movements:			
Clock	Ms	C	161
Marking of	Ms	C	161
Watch	Ms	C	161
Mule shoes	Ms	FL	554
Musical instruments and phonographs	Ms	N	373, 374
Musk	In progress	A	49
Myrobolans fruit	Ms	FL	553
Myrrh	In progress	N. S. P. F.	.....
Nails:			
Cut	Ms	FL	554
Horseshoe	Ms	FL	554
Wire, wrought iron or steel	Ms	FL	554
All other, etc	Ms	FL	554
Naphthalene (act Sept. 8, 1916)	In progress	.....	.....
Natural tanning materials	do	FL	624
Naval stores industry	Ms	FL	626, 635,
Needles:			
Crochet	Ms	C	135
Knitting	Ms	C	135
Latch	Ms	C	135
Sewing machine	Ms	C	135
Tape	Ms	C	135

Subject.	Status.	Tariff act of 1913.	
		Schedule.	Paragraph.
Netherlands, The (see Colonial Tariff Policies)	In progress		
Nets, gill netting, etc., flax, hemp, or ramie	do	J	271
New Zealand flax	do	FL	497
Nickel:			
Alloy	Ms	C	155
Bars	Ms	C	155
In pigs, etc	Ms	C	155
Ore	Ms	FL	565
Oxide of	Ms	C	155
Nippers and pliers	Ms	C	166
Niter cake or salt cake (sulphate of soda, crude)	Ms	FL	605
Nitrates of soda, calcium, and potash, and nitrite of soda	Ms	A and FL	64, 67, 440, 580, 605
Nitric acid	Ms	FL	387
Nitrite of soda	Ms	A	67
Nutgalls (see Tannic acid, etc.)	Ms	FL	624
Nux vomica	In progress	FL	558
Oakum	do	FL	559
Oats (see Report on Agricultural Trade with Canada)	Ms	G	192
Ocher	In progress	A	55
Odoriferous or aromatic substances, natural or synthetic, n. s. p. f	do	A	49
Oilcloths, cotton and other fiber	Ms	I	254
Oils:			
Birch tar	In progress	FL	561
Chinese nut	do	FL	561
Cod and cod liver	do	FL	561
Distilled and essential—			
Eucalyptus	do	N. S. P. F.	
Origanum, red or white	do	A	46
Pennyroyal	do	N. S. P. F.	
Peppermint	do	A	46
Sassafras	do	N. S. P. F.	
Spearmint	do	N. S. P. F.	
Expressed—			
Bean or sesame	Ms	A	45
Castor	Ms	A	45
Flaxseed	Ms	A	45
Linseed	Ms	A	45
Peanut	Ms	A	45
Poppyseed	Ms	A	45
Rapeseed	Ms	A	45
Sesame or bean	Ms	A	45
Ichthyol	In progress	FL	561
Palm and palm kernel	Ms	FL	561
Oilstones (see Abrasives)	Ms	N. S. P. F.	
Olives	In progress	G	218
Opium	Ms	A	47
Derivatives of	Ms	A	47
Optical Glass and Chemical Glassware	Printed		
Optical glass	Ms	FL	494
Orange oil	In progress	A	46
Oranges (see Citrus fruits)	do	G	220
Orchil or orchil liquid (see Cudbear)	Ms	FL	564
Ores:			
Antimony	Ms	FL	396
Chromic	Ms	FL	448
Cobalt	Ms	FL	453
Iron	Ms	FL	518
Iron, manganiferous	Ms	FL	518
Lead-bearing	Ms	C	152
Manganese	Ms	FL	540
Nickel	Ms	FL	565
Nickel matte	Ms	FL	565
Platinum, metals	Ms	FL	565
Tin	Ms	FL	631
Tungsten-bearing	Ms	FL	633
Zinc-bearing	Ms	C	162
Orris root	Ms	N. S. P. F.	
Advanced in value	Ms	N. S. P. F.	
Osage orange	In progress	N. S. P. F.	
Osmiridium (see Iridium)	Ms	C	
Osmium, rhodium, and ruthenium	Ms	FL	517
Outline of Works and Plans of Tariff Commission	Printed*		
Oxalic acid (see Acids of par. 1)	Printed	A	1
Oxides of aluminum (see Abrasives)	Ms	N. S. P. F.	
Oxides of lead, litharge, red lead, and orange mineral (see Pigments)	Ms	A	56

Subject.	Status.	Tariff act of 1913.	
		Schedule.	Paragraph.
Paints, colors, etc., n. s. p. f.	In progress.	A	68
Palladium	Ms	FL	517
Palm and palm kernel oil	Ms	FL	561
Papers and Books (No. 1, Tariff Information Series)	Printed *		
Para-acetphenetidin (see Acetphenetidin)	Ms	A	18
Paris green and London purple	Ms	FL	569
Paris white	Ms	A	60
Peanut oil (see Oils, expressed)	Ms	A	45
Peat moss	Ms	N	377
Pebbles for grinding (see Abrasives)	Ms	N. S. P. F.	
Pencil leads	In progress.	N	379
Pencils	do	N	378
Penholders	do	N	157
Pennyroyal oil (see Oils, distilled and essential)	do	N. S. P. F.	
Pens	do	C	156,157
Peppermint oil (see Oils, distilled and essential)	do	A	46
Perforated metal	do	N. S. P. F.	
Perfumery and cosmetics (see act of Oct. 3, 1917, providing additional duty on alcoholic content).	do	A	48
Persian berries	Ms	A	30
Peru (see Balsams)	Ms	A	9
Phenol, carbolic acid (act Sept. 8, 1916)	In progress.		
Phenolphthalein	Ms	A	18
Phonographs (see Musical instruments)	Ms	N	374
Phosphates	In progress.	FL	574
Phosphate of soda	Ms	A	67
Phosphorus	Ms	FL	575
Photographic goods	Ms.	N and FL.	380,576
Photographic plates, films, cameras, motion-picture films	In progress.	N	380
Phthalic acid (act Sept. 8, 1916)	Ms		
Pig iron (Bessemer, basic, forge, foundry, malleable, low-phosphorus)	Ms	FL	518
Pigments:			
Black (bone, ivory, gas, lamp)	Ms	A	52,53,55,56,59,63
Iron oxide			
Lead oxides (litharge, orange mineral)			
Ultramarine blue			
Vandyke brown (Cassell brown or earth)			
Vermilion reds			
Pigs:			
Lead	Ms	C	153
Nickel	Ms	C	155
Tin	Ms	FL	631
Zinc	Ms	C	163
Pile fabrics:			
Cotton	Ms	I	257
Flax, hemp, or ramie	In progress.	J	280
Silk	Ms	L	314
Pine oils (see Naval stores industry)	Ms	N. S. P. F.	
Pipes and smokers' articles	Ms	N	381
Pistols:			
Automatic	In progress.	C	133
Magazine	do	C	133
Revolving	do	C	133
Pit saws	do	C	139
Pitch and tar of wood (see Hardwood distillation industry; Naval stores industry)	Ms	FL	626
Plate glass, cast, polished, unsilvered	Ms	B	88
Plates:			
Aluminum	Ms	C	143
Copper	Ms	C	147
Iron or steel, coated with tin, etc	Ms	C	109
Nickel	Ms	C	155
Terne	Ms	C	109
Tin	Ms	C	109
Plated and sterling silver ware	Ms	N. S. P. F.	
Platinum:			
Crude	Ms	FL	565
Manufactures of, n. s. p. f.	Ms	C	167
Refined	Ms	FL	578
Pliers and nippers	Ms	C	166
Plumbago (see Graphite)	Ms	FL	579
Plush, hatters'	Ms	N	382
Poker chips (see Dice, dominoes, etc.)	In progress.	N	341
Polishing cloths, mop rags, etc	do	I	264
Pomegranate	do	N. S. P. F.	
Pool balls (see Dice, dominoes, etc.)	do	N	341
Poplar bark	do	N. S. P. F.	
Poppyseeds	Ms	G	212
Poppy-seed oil (see Oils, expressed)	Ms	A	45
Potash Industry, The	Printed		
Potash and potassium compounds	Ms	A and F L.	64,508

Subject.	Status.	Tariff act of 1913.	
		Schedule.	Paragraph.
Potassium:			
Acid tartrate (see Tartaric acid)	Ms	N. S. P. F.	
Bicarbonate of, refined	Ms	A	64
Bichromate	Ms	A	64
Binoxalate (salts of sorrel) (see Oxalic acid)	Ms	N. S. P. F.	
Bitartrate (see Argols, etc.)	Ms	A	8
Carbonate of	Ms	FL	580
Chlorate of	Ms	A	64
Chromate of	Ms	A	64
Citrate (see Citric acid)	Ms	N. S. P. F.	
Cyanide of	Ms	FL	580
Nitrate of—			
Crude	Ms	FL	580
Refined	Ms	A	64
Oxalate (see Oxalic acid)	Ms	N. S. P. F.	
Permanganate of	Ms	A	64
Potato:			
Dextrin	Printed	A	36
Flour	do	FL	581
Starch (see The Domestic Potato Products Industry)	do	G	234
Potato Products Industry, The Domestic	do		
Potatoes (see report on Agricultural Trade with Canada)	Ms	FL	581
Potatoes, desiccated, dried	Ms	FL	581
Portugal (see Colonial Tariff Policies)	In progress		
Pottery	do	FL	654
Powder:			
Bleaching	Ms	A	12
Bronze	Ms	C	146
Fulminating	Ms	FL	490
Poultry netting (see Woven wire fencing)	Ms	FL	645
Preferential tariffs (see Colonial Tariff Policies)	In progress		
Presscloth:			
Camel's hair	Ms	K and FL	288, 422
Hair	Ms	N	353
Prickly ash bark	In progress	N. S. P. F.	
Prussiates and cyanides of potash and soda	Ms	FL	580, 605
Pulpstones (see Abrasives)	Ms	N. S. P. F.	
Pumice (see Abrasives)	Ms	B	75
Pumice stone, rottenstone, and tripoli (including provisions in par. 614 Free List).	Ms	B	75
Pyrites and Sulphur	Printed		
Pyrites (or sulphur) ore	Ms	FL	617
Pyrogallic acid (see Acids of par. 1, etc.)	Ms	A	1
Pyroligneous acid (see Acetic acid)	Ms	FL	387
Pyrophoric alloys (see Gas mantles)	Printed	N. S. P. F.	
Pyroxylin plastics	Ms	A	25
Quassia	In progress	N. S. P. F.	
Quercitron and flavine	Ms	N. S. P. F.	
Quicksilver or mercury	Ms	C	159
Quinine and all alkaloids from cinchona bark	In progress	FL	584
Radium, salts of	Ms	FL	585
Rails, steel	Ms	FL	587
Railway wheels	Ms	C	142
Raisins	In progress	G	218
Ramie	do	FL	497
Ramie hat braids and manufactures of	do	N	334
Rapeseed oil (see Oils, expressed)	Ms	A	45
Raw cotton	Ms	FL	467
Raw silk, cocoons and waste	Ms	FL	599, 600
Raw skins	In progress	FL	604
Razor blades (see Cutlery)	Ms	C	128
Razors	Ms	C	128
Recent Developments in the Japanese Cotton and Silk Industries	In progress		
Reciprocity and Commercial Treaties:			
Bargaining Tariffs and Commercial Treaties of European States, special attention to—			
France	Printed		
Germany	do		
Russia	do		
Canada, commercial relations with the United States—Reciprocity experiences of the United States—			
The Canadian reciprocity treaty of 1854	do		
The Hawaiian reciprocity treaty of 1875	do		
Agreements under the tariff act of 1890	do		
Treaties and agreements under the tariff act of 1897	do		
Two-schedule provision of the tariff act of 1909	do		
Reciprocity section of the tariff act of 1913	do		
Brazilian preferential arrangement	do		

Subject.	Status.	Tariff act of 1913.	
		Schedule.	Paragraph.
Reciprocity and Commercial Treaties—Continued.			
Canada, commercial relations with the United States—Reciprocity experiences of the United States—Continued.			
The Cuban reciprocity treaty of 1902	Printed		
Commercial relations of the United States with Newfoundland.	do		
The attempt to establish a reciprocity arrangement with Canada, 1910-11.	do		
Most-favored-nation clause in commercial treaties	do		
Red dyewoods (Brazil wood, camwood, barwood, sanders)	In progress		
Red woods	do	N. S. P. F.	
Regulus (see Copper ore, etc.)	Ms	C	461
Rendered oils and greases n. s. p. f.	In progress	A	44
Revision of the Customs Administrative Laws	Printed		
Rhodium	Ms	FL	517
Rhubarb root	In progress	N. S. P. F.	
Rice	do	G	193
Rochelle salts or Seignette salts	Ms	A	8
Rifles:			
Breech-loading	In progress	C	133
Combination	do	C	133
Muzzle-loading	do	C	132
Rockingham earthenware	Ms	B	78
Rods:			
Aluminum	Ms	C	143
Copper	Ms	C	147
Nickel	Ms	C	155
Rivet, screw, fence, etc	Ms	C	113
Steel, rolled wire	Ms	C	110
Wire	Ms	C	110
Roller bearings	Ms	C	106
Rope and strand wire	Ms	C	114
Rosin and rosin oils (see Naval stores industry)	Ms	N. S. P. F.	
Rottenstone (see Abrasives)	Ms	FL	614
Roving and sliver, cotton	Ms	I	250
Rugs:			
Flax	Ms	J	272, 273
Hemp	Ms	J	272, 273
Jute	Ms	J	272, 273
Vegetable fiber	Ms	J	272, 273
Ruthenium	Ms	FL	517
Saccharin	Ms	E	179
Saffron, safflower extract and saffron cake	In progress	A	31
Salep or salop	Ms	FL	592
Salicin	Ms	FL	591
Salicylic acid (act Sept. 8, 1916)	Ms		
Salol	Ms	A	18
Sal-soda or washing soda (see Soda-ash and other carbonates)	Ms	A	67
Salt	Ms	FL	593
Salt cake or niter cake	Ms	FL	605
Salts of bismuth, gold, platinum, rhodium, silver, and tin	Ms	A	65
Sandrac	In progress	N. S. P. F.	
Sandal wood (see Red woods)	Ms	N. S. P. F.	
Sander's wood	Ms	N. S. P. F.	
Santonin and its combinations	Ms	FL	594
Sarsaparilla root	Ms	A	39
Sassafras leaves	Ms	N. S. P. F.	
Sassafras oil (see Oils, distilled and essential)	In progress	N. S. P. F.	
Sassafras bark	do	N. S. P. F.	
Satin-white and artificial sulphate of lime	do	A	51
Saws:			
Back	Ms	C	139
Circular	Ms	C	109
Crosscut	Ms	C	109
Drag	Ms	C	109
Hand	Ms	C	109
Mill	Ms	C	109
Pit	Ms	C	109
Steel band	Ms	C	109
All other n. s. p. f.	Ms	C	139
Scammony root	In progress	N. S. P. F.	
Schappe silk yarn or spun silk	Ms	L	312
Scientific Instruments	Printed	FL	573, 653
Scoured wool	Ms	FL	650
Scrap:			
Aluminum	Ms	C	143
Gas-mantle (see Gas mantles)	Printed	C	154
Iron, wrought	Ms	FL	518
Lead	Ms	C	153
Steel	Ms	FL	518
Tin	Ms	FL	631

Subject.	Status.	Tariff act of 1913.	
		Schedule.	Paragraph.
Scythestones (see Abrasives)	Ms	N. S. P. F.	
Seaweeds and moss	In progress	N	372
Second annual report	Printed		
Secondary metals:			
Aluminum	In progress	C	143
Antimony	do	C	144
Copper	do	FL	461
Lead	do	C	153
Nickel	do	C	155
Tin	do	FL	631
Zinc	do	C	163
Seeds:			
Anise	do	G	212
Aromatic, not edible, advanced in value	do	A	7
Aromatic, not garden, crude	do	FL	477
Beet (except sugar beet)	do	G	212
Cabbage	do	G	212
Canary	do	G	212
Caraway	do	G	212
Cardamom	do	FL	595
Carrot	do	G	212
Castor bean	Ms	G	212
Cauliflower	In progress	FL	595
Celery	do	FL	595
Collard	do	G	212
Coriander	do	FL	595
Corn salad	do	G	212
Cotton	do	FL	595
Cummin	do	FL	595
Eggplant	do	G	212
Fennel	do	FL	595
Fenugreek	do	FL	595
Flower	do	FL	595
Grass	do	FL	595
Hemp	Ms	FL	595
Hoarhound	In progress	FL	595
Imported by Department of Agriculture	do	FL	577
Kale	do	G	212
Kohl-rabi	do	G	212
Linseed	Ms	G	212
Mangelwurzel	In progress	FL	595
Mustard	do	FL	595
Not edible, n. s. p. f	do	FL	595
Of morbid growth, not edible—			
Advanced in value	do	A	27
Crude	do	FL	477
Parsley	do	G	212
Parsnip	do	G	212
Pepper	do	G	212
Poppy	Ms	G	212
Radish	In progress	G	212
Rape	Ms	FL	595
Rutabaga	In progress	G	212
St. John's bread or bean	do	FL	595
Sesamum	Ms	A	45
Sorghum	In progress	FL	595
Spinach	do	G	212
Sugar-beet	do	FL	595
Sugar cane for	do	FL	595
Turnip	do	G	212
Seignette salts, or Rochelle salts (see Argols, etc.)	Ms	A	8
Senna leaves	Ms	N. S. P. F.	
Sesame or bean oil (see Oils, expressed)	Ms	A	45
Sesquicarbonate of soda	Ms	A	67
Sewing silk, twist, floss, etc	Ms	L	313
Sheets and pillow cases, cotton	In progress	I	264
Shoes, horse, mule, and ox	Ms	FL	554
Shoes and boots (see Leather and leather products)	Ms	FL	530
Shovels and scoops	Ms	N. S. P. F.	
Siam, Tariff (History and System)	Ms		
Sienna and umber	In progress	A	55
Silicate of soda and silicic acid	Ms	FL	387, 605
Silicic acid	Ms	FL	387
Silk:			
Bolting cloth	Ms	FL	422
Cocoons, silk waste, and raw silk	Ms	FL	599, 600
Fabrics, woven	Ms	L	318
Handkerchiefs	In progress	L	315
Partially manufactured, and long noils	Ms	L	311
Pile fabrics	Ms	L	314
Ribbons	Ms	L	316

Subject.	Status.	Tariff act of 1913.	
		Schedule.	Paragraph.
Silk—Continued.			
Small wares	In progress	L	316
Thrown	Ms	L	313
Waste, silk cocoons, and raw silk	Ms	FL	509, 600
Wearing apparel	In progress	L	317
Silk and Manufactures of Silk (No. 3, Tariff Information Series)	Printed*	L	
Silk and cotton industries, Recent developments in the Japanese	In progress		
Silver leaf	In progress	C	149
Simaruba bark	do	N. S. P. F.	
Single yarns of flax, hemp or ramie	Ms	J	270
Sirup (see Molasses)	Ms	E	177
Sirup, maple	Ms	E	178
Sisal	In progress	FL	497
Sliver and roving, cotton	Ms	I	250
Small package goods (see Chemicals and medicinal compounds)	Ms	A	17
Smalts (see Cobalt, etc.)	Ms	A	63
Snap fasteners, buckles, hooks and eyes	Ms	C	151, 167
Soap bark	In progress	N. S. P. F.	
Soaps	Ms	A	66
Sod, seal, herring, and other fish oils (see also par. 561 FL)	In progress	A	44
Soda-ash and sodium carbonates	Ms	A and FL	67, 605
Soda crystals	Ms	A	67
Sodium bicarbonate	Ms	A	67
Sodium:			
Carbonate	Ms	A	67
Chlorate	Ms	A	67
Chloride (salt)	Ms	FL	593
Citrate (see Citric acid, etc.)	Ms	N. S. P. F.	
Formate (see Formic acid)	Ms	N. S. P. F.	
Hydroxide or hydrate	Ms	A	67
Nitrate	Ms	FL	605
Nitrite	Ms	A	67
Oxalate (see Oxalic acid)	Ms	N. S. P. F.	
Phosphate	Ms	A	67
Potassium lactate (lactolin)	Ms	N. S. P. F.	
Tartrate	Ms	N. S. P. F.	
Sulphate, Glauber's salt	Ms	A	67
Sulphide	Ms	A	67
Sulphite—			
Hydrosulphite	Ms	N. S. P. F.	
Hyposulphite or thiosulphate	Ms	A	67
Supercarbonate of	Ms	A	67
Soluble tartar (see Argols, etc.)	Ms	A	8
Soya beans	Ms	FL	606
Spain (see Colonial Tariff Policies)	In progress		
Spangles and beads	Ms	N	333
Spanish brown and oxides of iron	In progress	A	55
Spearmint oil (see Oils, distilled and essential)	do	N. S. P. F.	
Spiegeleisen (see Ferromanganese)	Ms	FL	518
Spikes, forged	Ms	FL	554
Sponges	In progress	A	68
Sprinkler tops	do	C	164
Spun silk or schappe silk yarn	Ms	L	312
St. Ignatius beans	In progress	N. S. P. F.	
Stannic chloride or tin tetrachloride (see Tin chloride)	Ms	N. S. P. F.	
Stannous chloride or bichloride of tin	Ms	N. S. P. F.	
Staples, brads, and tacks	Ms	FL	554
Starch	Printed	G	234
Steatite	Ms	A	69
Crude	Ms	FL	621
Steel (see also Iron and steel):			
Alloys	Ms	C	110
Band saws	Ms	C	139
Billets and bars	Ms	C	110
Blooms and billets	Ms	C	110
Castings, sheets, and plates, Bessemer, etc., processes	Ms	C	110
Crucible, electric, etc., processes	Ms	C	110
Ingots	Ms	C and FL	110, 613
Shavings	Ms	C	111
Slabs	Ms	C	110
Wool	Ms	C	111
Stibnite containing antimony	Ms	FL	396
Straw:			
Braids	In progress	N	335
Floor mattings	do	J	272
Hats	Ms	N	335
Strips:			
Aluminum	Ms	C	143
Copper	Ms	C	147
Nickel	Ms	C	155

Subject.	Status.	Tariff act of 1913.	
		Schedule.	Paragraph.
Strontium compounds	Ms	FL	615
Strophantus seed	In progress	N. S. P. F.	
Structural iron or steel	Ms	C	104
Structural shapes	Ms	C	104
Strychnia or strychnine	Ms	FL	616
Styrax	Ms	N. S. P. F.	
Sugar Industry, Costs of Production in the	Printed	E	
Sugar:			
Maple	Ms	E	178
Of milk	Ms	FL	547
Raw	Ms	E	177
Sugar machinery	Ms	FL	391
Sulphate of:			
Alumina	Ms	A	6
Ammonia	Ms	FL	395
Baryta	Ms	A	51
Copper	Ms	FL	421
Iron (see Copperas)	Ms	FL	462
Lime, artificial	Ms	A	51
Magnesia	Ms	A	42
Morphia (see Opium and derivatives)	Ms	A	47
Potash	Ms	FL	580
Quinia	Ms	FL	584
Soda, crude	Ms	FL	605
Crystallized, Glauber's salt	Ms	A	67
Zinc	Ms	A	62
Sulphide of soda	Ms	A	67
Sulphite, hydrosulphite and thiosulphate of soda	Ms	A	67
Sulphur chlorides	Ms	N. S. P. F.	
Sulphur or brimstone	Ms	FL	617
Sulphur ore, or pyrites	Ms	FL	617
Sulphuret of iron (see Pyrites)	Ms	FL	617
Sulphuric acid	Ms	FL	387
Sumac	Ms	A	30
Sunn	In progress	FL	497
Surgical Instrument Industry of the United States (No. 7 Tariff Information Series.)	Printed		
Survey of the British Wool Manufacturing Industries	do		
Surveying instruments	In progress	B	94
Sweet potatoes and yams	Ms	FL	581
Synthetic phenolic resins (act Sept. 8, 1916)	In progress		
Synthetic tanning materials (act Sept. 8, 1916)	do		
Trails	Ms	FL	587
Table damask, cotton	In progress	I	263
Tacks, brads and staples	Ms	FL	554
Talc	Ms	A	69
Talcum	Ms	A	69
Tamarind	In progress	FL	653
Tannic acid and tannin, gallic acid, pyrogallic acid, and nutgalls	Printed	A and FL.	1, 30, 624
Tannin (see Tannic acid)	do	A	1
Tapes, flax measuring	In progress	J	275
Tar and pitch of wood (see Hardwood distillation industry; Naval stores industry).	Ms	FL	626
Tar and tar oils (act Sept. 8, 1916)	Ms		
Tariff policies, colonial (see Colonial Tariff Policies)	In progress		
Tartaric acid	Printed	A	1
Tartar emetic	Ms	N. S. P. F.	
Tea, n. s. p. f	Ms	FL	627
Tea, for manufacturing purposes	Ms	A	13
Terne and tin plate	Ms	C	109
Terpin hydrate	Ms	A	18
Tetrachloride of tin (see Tin chlorides)	Ms	N. S. P. F.	
Thorianite (see Gas mantles)	Printed	N. S. P. F.	
Thiosulphate of soda (see Sulphite of soda)	Ms	A	67
Third annual report	Printed		
Thorite (see Gas mantles)	do	C	154
Thorium nitrate (see Gas mantles)	do	C	154
Threads, twines, etc.:			
Cotton, sewing, darning, etc	Ms	I	251
Flax, hemp, or ramie	In progress	J	269
Thrown silk	Ms	L	313
Thymol	Ms	A	18
Thyme oil	In progress	A	46
Tiff—also called barytes, barium sulphate, barite, and heavy spar (see Barium compounds).	Ms	A	51
Tin:			
Grain	Ms	FL	631
Granulated	Ms	FL	631
In bars	Ms	FL	631

Subject.	Status.	Tariff act of 1913.	
		Schedule.	Paragraph.
Tin—Continued.			
In blocks	Ms	FL	631
In pigs	Ms	FL	631
Ore	Ms	FL	631
Oxide of, black	Ms	FL	631
Plates coated with metal	Ms	C	109
Plates	Ms	C	109
Scrap	Ms	FL	631
Taggers	Ms	C	109
Tin and terne plate	Ms	C	109
Tin chlorides	Ms	N. S. P. F.	.....
Tin tetrachloride or stannic chloride (see Tin chlorides)	Ms	N. S. P. F.	.....
Tinsel:			
Products	Ms	C	150
Wire	Ms	C	150
Titanium and ferrotitanium	Ms	C	102
Tobacco and manufactures of	In progress.	F	181–185
Tolu (see Balsams)	Ms.	A	9
Tonga bark	In progress.	N. S. P. F.	.....
Tonka beans	do	A	70
Tools, machine	Ms	C	165
Towels and bath mats, cotton	In progress.	I	264
Toys	do	N	342
Tracing cloth	Ms	I	254
Treaties of the World, Digest of Commercial	In progress.	.....	.....
Tripoli (see Abrasives)	Ms	FL	614
Tumeric	In progress.	N. S. P. F.	.....
Tungsten-bearing ores	Printed	FL	633
Turmeric	In progress.	FL	634
Turpentine (see Naval stores industry)	Ms.	FL	635
Twist, silk	Ms	L	313
Type metal and types (see Antimonial lead; see also par. N, subsec. 1, tariff act of Oct. 3, 1913).	Ms	C	160
Ultramarine and wash blue (see Pigments)	Ms	A	52
Umbrellas and canes	In progress.	N	383
Underwear, cotton	Ms	I	261
United States (see Colonial Tariff Policies)	In progress.	.....	.....
Upholstery goods, cotton	Ms	I	258
Upper leather	Ms	FL	530
Urea	Ms	A	18
Valerian oil	In progress.	A	46
Vanadium ore	Ms	FL	549
Vandyke brown, Cassell brown or earth (see Pigments)	Ms	N. S. P. F.	.....
Vanilla beans	In progress.	A	70
Vanillin	do	A	70
Varnishes	do	A	58
Vegetable fibers, n. s. p. f	do	FL	497
Venetian red and oxides of iron	do	A	55
Venetians, Cotton (No. 10, Tariff Information Series)	Printed	.....	.....
Verdigris (see Blue vitriol and verdigris)	Ms	FL	421
Vermilion reds (see Pigments)	Ms	A	59
Wahoo bark	In progress.	N. S. P. F.	.....
War minerals, certain	Ms	.....	.....
Washing soda (see Soda-ash, etc.)	Ms	FL	605
Waste:			
Cotton	Ms	I and FL	250, 467
Silk	Ms	FL	599
Wool	Ms	FL	651
Watches and clocks	Ms	C	161
Watch:			
Cases	Ms	C	161
Dials, enameled	Ms	C	161
Jewels, movements, marking of movements	Ms.	C	161
Waterproof cloth	Ms	I	254
Wax	In progress.	N	367
Wearing apparel:			
Cotton (see Cotton knit goods)	do	I	259, 261
Cotton, made in part of lace	do	N	358
Flax, hemp, or ramie	do	J	278
Silk	do	L	317
Welsbach mantles (see Gas mantles)	Printed	N. S. P. F.	.....
Whale and sperm oil	In progress.	A and FL	44, 561
Wheat (see report on Agricultural Trade with Canada)	Ms	FL	644
Wheat flour	Ms	FL	644
Wheat products	Ms	FL	644
Wheels, railway	Ms	C	142
Whetstones (see Abrasives)	Ms	FL	507
White lead	Ms	A	56
White-pine bark	In progress.	N. S. P. F.	.....

Subject.	Status.	Tariff act of 1913.	
		Schedule.	Paragraph.
Whiting and Paris white	Ms	A	60
Wild-cherry bark	In progress	N. S. P. F.	
Window glass, cylinder	Ms	B	85
Window hollands, cotton	Ms	I	254
Wine lees (see Argols, etc.)	Ms	A	8
Wire:			
Galvanized and plain, iron and steel	Ms	C and FL	114, 645
Heddles and healds	Ms	C	114
Nails and spikes	Ms	FL	554
Rods, iron and steel	Ms	C and FL	110, 113, 554
Rope and strand	Ms	C	114
All other	In progress	C	114
Witch hazel, bark and leaves	do	A	27
Witherite (see Barium compounds)	Ms	FL	646
Wood and manufactures thereof (see Report on the Lumber Industry).	Ms	D	
Wood:			
Alcohol	Ms	FL	393
Briar	Ms	D	168
For tanning	Ms	FL	624
Manufactures of, n. s. p. f	Ms	D	176
Wood-screws of iron or steel	Ms	C	140
Wool (see Wool-growing industry):			
Blankets	Ms	K	289
Carpet and native	Ms	K	
Cloths	In progress	K	288
Cross-bred	Ms	K	
Dress goods	Ms	K	290
English breeds	Ms	K	
Flannels	Ms	K	289
Of Merino blood	Ms	K	
Raw	Ms	K	
Tops	Ms	K	286
Waste materials and rags	Ms	FL	651
Yarns	Ms	K	287
Wool-growing industry:			
Australia	Ms	K	
Canada	Ms	K	
Continental Europe	Ms	K	
Great Britain	Ms	K	
In the range States of the United States	Ms	K	
In the farm States of the United States	Ms	K	
New Zealand	Ms	K	
South Africa	Ms	K	
South America	Ms	K	
Wool Manufacturing Industries, Survey of the British	Printed		
Works of art	Ms	N and FL	376, 611, 652-656
Woven silk fabrics	Ms	L	318
Woven wire fencing and poultry netting	Ms	C and FL	114, 645
Wrought iron, scrap and steel scrap (see Iron and steel)	Ms	FL	518
Wulfenite (see Molybdenum ore)	Ms	N. S. P. F.	
Yarn:			
Coir	In progress	FL	459
Cotton (No. 12, Tariff Information Series)	Printed		
Flax	Ms	J	270
Hemp	Ms	J	270
Jute	In progress	J	267
Ramie	Ms	J	270
Wool	Ms	K	287
Zaffre or zaffer, cobalt, cobalt oxide, and smalts	Ms	FL	657
Zinc-bearing ores	Ms	C	162
Zinc:			
Chlorides	Ms	A	62
Dust	Ms	C	163
Manufactures of (plates, sheets, etc.)	Ms	C	163
Manufactures of, n. s. p. f.	Ms	C	167
Old and worn out	In progress	C	163
Ore	Printed	C	162
Oxide and pigments	Ms	A	61
Sulphate	Ms	A	62

UNITED STATES TARIFF COMMISSION
WASHINGTON

Tariff Information Series—No. 18

Barytes, Barium Chemical, and Lithopone Industries

Including

Costs of Production, 1919

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INTRODUCTION.

This pamphlet is a survey of existing conditions in the barytes, barium chemical, and lithopone industries, with special reference to the rôle of the tariff in their development in the United States. It includes a study of the costs of production in the three related industries.

The report as presented is divided into five parts, as follows:

I. *Summary of the barytes, barium chemical, and lithopone industries.*—This cites the provisions in the tariff act of 1913 covering the articles discussed in the report and presents the salient competitive conditions relating to the three allied industries.

II. *The barytes industry.*—This chapter discusses the trade statistics of the barytes industry, the principal producing countries, recent developments in the domestic industry, and the relation of the barytes industry to the barium chemical and lithopone industries.

III. *The barium chemical industry.*—Our prewar dependence on imports of this class of chemical salts and the establishment of an industry in this country during the war are discussed in detail.

IV. *The lithopone industry.*—The dependence of this industry on imported barytes prior to the war, the effect of the lithopone industry on the development of domestic deposits of barytes, and the requirements of the lithopone industry are pointed out.

V. *Costs of production in the barytes, barium chemical, and lithopone industries.*—This chapter gives in considerable detail the cost of producing crude barytes in western and southern mines in 1916 and 1919; the cost of producing ground barytes in 1914, 1916, and 1919, and of barium chemicals and lithopone in 1919.

In the preparation of this report the Tariff Commission had the services of C. R. DeLong, G. P. Comer, and E. M. Whitcomb, of the Commission's staff.

PART I

SUMMARY OF THE BARYTES, BARIUM CHEMICAL AND LITHOPONE INDUSTRIES

PART I.

SUMMARY OF THE BARYTES, BARIUM CHEMICAL, AND LITHOPONE INDUSTRIES.

The articles discussed in this report are provided for as follows in the tariff act of October 3, 1913:

10. Barium, chloride of, ¼ cent per pound; dioxide of, 1½ cents per pound; carbonate of, precipitated, 15 per centum ad valorem.

51. Baryta, sulphate of, or barytes, including barytes earth, unmanufactured, 15 per centum ad valorem; manufactured, 20 per centum ad valorem; blanc-fixe, or artificial sulphate of barytes, * * * 20 per centum ad valorem.

61. * * * lithopone and white sulphide of zinc, 15 per centum ad valorem.

BARYTES.

The source of barium is the naturally occurring minerals—barytes (barium sulphate) and witherite (barium carbonate). Metallic barium is, at present, of no industrial importance. The barium compounds manufactured from these minerals, by chemical processes, constitute an important class of commercial articles. Barytes, the more widely distributed ore, is the one generally used. England and Germany possess, in addition to barytes, deposits of witherite, which can be mined economically, and a small portion of the demand is supplied by this mineral. Barytes, on account of its whiteness, high specific gravity, and chemical inertness, is used in the ground form chiefly as a filler in paints, paper, linoleum, and rubber goods. Its use as a raw material in the manufacture of the pigment, lithopone, and the various barium chemicals is important. In 1917, with a maximum consumption of barytes, about 43 per cent was used in the manufacture of lithopone, 25 per cent in barium chemicals, and the remainder in ground barytes. Witherite is used chiefly as a filler in rubber goods and in the manufacture of barium chemicals.

Prior to the war the domestic barytes industry supplied from 55 to 65 per cent of the consumption (80,000 tons in 1913) of crude barytes in the United States. Lithopone was then the only product manufactured in this country on a large scale from crude barytes by chemical processes, and the barytes necessary for its production was imported, chiefly from Germany. Before the war Germany was the largest producer of barytes, with an output of about 300,000

short tons a year. Great Britain ranked second and the United States third. The domestic production of crude barytes, under war conditions, increased fourfold, from about 50,000 tons in 1914 to over 200,000 tons in both 1916 and 1917. The production of the United States is now second only to Germany's prewar output. The production of crude barytes in this country during the war was sufficient to meet domestic requirements.

The domestic industry prior to the war was localized; about 65 per cent of the output of crude barytes was mined in Missouri and supplied mid-western manufacturers of ground barytes. During the war the increased domestic demand was met largely by the development of southern deposits of barytes in Georgia, Tennessee, and Kentucky, and by a doubling of production in Missouri. The greatest (State) production shifted from Missouri to Georgia in 1916. Since 1915 Georgia has supplied about 50 per cent of the total domestic output. The industry as it now exists is in two distinct localities—(1) the middle western district, represented chiefly by Missouri, and (2) the southern district, represented chiefly by Georgia, Tennessee, and Kentucky. In addition to these two producing localities, there are two principal markets for crude barytes—the Atlantic coast market (from Baltimore to New York) and the middle western market (St. Louis and Chicago). The western producers and consumers are little affected by a tariff on *crude* barytes. On the other hand, eastern consumers of barytes before the war secured their supplies chiefly from Germany. Since the cessation of imports the Atlantic coast market has been supplied with crude barytes from the southern producing district, because of the differential in freight rates of $1.24 a short ton (May 29, 1920) in favor of this district over the middle western district. This localization of the industry complicates the tariff problems.

Prior to the war domestic ground barytes produced in the middle western district was able to compete in the Atlantic coast market with imported ground barytes under the duty of $5.25 per ton (act of 1909). At that time foreign competition was chiefly in the crude grade, imports of ground barytes being only about 15 per cent of the imports of the crude. During the war middle western ground barytes continued to supply a large part of the Atlantic coast market, notwithstanding the advantage of the southern district in freight rates. This may be accounted for by the fact that the middle western ore is a softer variety and grinds easier, and by the circumstance that the southern deposits were developed primarily to supply the raw material requirements of the eastern lithopone and barium chemical manufacturers. The producers in the southern district are therefore particularly interested in maintaining the eastern market for crude barytes, while the middle western producers are more in-

terested in retaining this same market for ground barytes. The situation in regard to an outlet for middle western crude barytes has been improved during the war by the establishment in the Middle West of lithopone plants, which require crude barytes as their raw material.

The extent and availability of deposits in the United States are important factors in connection with the tariff. Unfortunately, little definite, official information is available, and owing to the general nature of deposits it would be practically impossible to arrive at an accurate estimate of the total domestic resources. Under the stimulus of war conditions the domestic production supplied the entire domestic consumption. The possibility of increasing the present output of barytes appears to be most promising in the Georgia and Tennessee districts. These districts seem to contain large quantities of ore and could probably be developed to meet an increased demand of eastern manufacturers. In these districts, however, geological and geographical disadvantages will probably hinder domestic barytes from competing on even terms in the Atlantic coast market with crude barytes imported from Germany.

BARIUM CHEMICALS.

The barium chemicals discussed in this report include the barium salts mentioned in paragraph 10, and blanc fixe in paragraph 51, of the act of 1913, as well as other barium salts not mentioned specifically in the tariff. These chemicals, which are made either from barytes or witherite, have important industrial uses. The most important are as follows: *blanc fixe*, or precipitated barium sulphate (which is practically identical with ground barytes in chemical composition, but different in physical properties), used as an inert filler or pigment where a pure white product is necessary; *barium carbonate*, used chiefly in ceramics in the manufacture of enamel ware and some kinds of optical glass; *barium chloride*, used principally in the manufacture of blanc fixe and color lakes; and *barium dioxide*, used as the raw material for the production of hydrogen peroxide.

Prior to the war the United States was wholly dependent on imports for its supply of barium chemicals. Germany was the largest producer and furnished about two-thirds of the domestic requirements. About 90 per cent of the imports in 1914 were represented by three barium salts—barium carbonate, barium chloride, and barium dioxide. The cessation of imports and the war demand for barium chemicals (barium nitrate, blanc fixe, and barium dioxide) resulted in the establishment of an industry in this country. Domestic plants have been located chiefly in the East and Southeast, although there

are also plants in Ohio and Illinois. In some cases the plants have been located in close proximity to the domestic deposits of barytes. The output of barium chemicals has increased steadily each year from about 17,000,000 pounds in 1915 to over 46,000,000 pounds in 1918. The principal salts produced are blanc fixe, barium carbonate, and barium chloride, in the order of production in 1918. The domestic production of 46,000,000 pounds in 1918 may be compared with an importation in 1914 of 19,000,000 pounds in order to show the increased consumption of barium chemicals in the United States.

The chief markets for barium chemicals are in the East, and with normal conditions restored, the industry will be subjected to competition in these markets from imported barium chemicals. Eastern plants are so situated that they can use either imported or domestic barytes as the raw material. Those plants located close to the southern barytes deposits and in the Middle West will depend largely on domestic barytes. It is evident that a duty on barium chemicals should be considered in conjunction with a duty on the raw material, barytes.

LITHOPONE.

Lithopone, a white pigment, is a mixture consisting of about 70 per cent of barium sulphate and about 30 per cent of zinc sulphide. When first introduced, lithopone was known as "white sulphide of zinc," but this term, although retained in the tariff of 1913, is no longer in general use. Lithopone is used extensively in flat and enamel wall paints and as an inert filler in rubber goods, paper, linoleum, oilcloth, and window-shade cloth.

The raw materials for the manufacture of lithopone include barytes, coal or coke, zinc, and sulphuric acid. Prior to the war the entire lithopone industry was located along the Atlantic coast at or within a short distance of tidewater. The barytes requirements of the industry were supplied by imports, chiefly from Germany, at a cost less than the price at which domestic barytes could be purchased. War conditions forced lithopone manufacturers to develop southern deposits of barytes in order to have a supply of raw material. At the same time the manufacture of lithopone was started in the Middle West, thereby utilizing locally available crude barytes. An adequate supply of barytes is essential to the lithopone industry and should be given attention in considering duties on crude barytes and lithopone.

From 1910 to 1919 the domestic production of lithopone increased nearly sixfold, or from 25,000,000 pounds to about 145,000,000 pounds. The output during this period supplied from 84 to 100 per cent of the domestic consumption. On a basis of the 1919 production, about 80 per cent of the lithopone is produced in the Atlantic

coast district. The imports of lithopone have been small; the maximum importation was 7,500,000 pounds in 1914, compared with a domestic production the same year of about 65,600,000 pounds. Although there has been no official report of exports, it is known that a considerable export trade in lithopone has been developed during 1920.

Since barytes is one of their raw materials, lithopone manufacturers are naturally interested in obtaining a supply at the lowest possible cost, and they generally favor a low duty on crude barytes. Barytes enters into the cost of lithopone to the extent of about 14 per cent of the total factory cost, as shown under the cost of production on page 87. The effect of an increase or decrease in the cost of barytes, due to tariff influences or other causes, on the total cost of lithopone can, therefore, be calculated. Theoretically, any duty on lithopone should be compensatory of the duty on crude barytes to the extent revealed by the percentage of total cost given above. There are other factors entering into a consideration of the bearing of the tariff on lithopone, such as the competition between lithopone and other paint pigments.

PART II

THE BARYTES INDUSTRY

PART II.

THE BARYTES INDUSTRY.

DESCRIPTION AND USES.

Barium occurs in nature as the minerals—barytes (barium sulphate) and witherite (barium carbonate). The chemical compounds manufactured from these raw materials constitute an important class of commercial articles. Barytes is the more widely distributed ore and is the one generally used in the United States. The United Kingdom and Germany also possess witherite deposits which are used in the manufacture of barium chemicals. Barytes, also known as "barite," "heavy spar," and "tiff," is composed chiefly of barium sulphate ($BaSO_4$). When pure it consists of 65.7 per cent of barium oxide (BaO) and 34.3 per cent of sulphur trioxide (SO_3). It is usually a white, opaque or translucent mineral, but it is also found stained pink or brown owing to the presence of oxides of iron. The commercial grades of crude barytes contain from 90 to 95 per cent of barium sulphate. Crude barytes is graded according to the amount and kinds of impurities which it contains; particular attention is paid to the content of iron, lead, zinc, and silica. In trade two types of crude barytes are recognized, the "hard crystalline" variety and the "soft" variety. The former has a glassy appearance and can not be broken in the hand, while the soft variety has a milky appearance and can be easily crumbled. The soft type is preferred by the grinders, as it gives the highest grade of ground barytes because of its texture and because the impurities are such that they can be dissolved and eliminated by an acid bath. This grade is not so hard on the grinding machinery and is said to roast better than the hard variety. The hard variety can be used to better advantage in the lithopone and barium chemical industries than in the manufacture of ground barytes. Both the hard and soft barytes are found in this country. That found in Missouri is a soft friable ore. The barytes found in the Cartersville (Ga.) district is a hard crystalline ore. Both types are found in the Sweetwater (Tenn.) fields, the soft ore approaching the Missouri ore and the hard ore closely resembling the Cartersville ore.

The commercial uses of barytes, as such, are largely dependent on the fact that it is a heavy, white mineral, chemically inert, and comparatively cheap. The market price of crude barytes depends to a

large extent on the ease with which it can be ground, and that of ground barytes depends on color, fineness of grinding, and to some extent on its chemical purity.

Barytes as it enters commerce may be distinguished as follows:

1. Crude barytes, barytes ore, or "tiff," as it is known locally in Missouri, is the natural mineral in the condition in which it is mined, or after it has been washed and jigged to remove earthy and mineral impurities. This grade of barytes is used as the raw material for the manufacture of ground barytes, barium chemicals, and lithopone.

2. Ground barytes is the crude ore which has been washed, jigged, and ground very fine. If the natural mineral is of the desired degree of whiteness, which is rarely the case in this country, it receives no further treatment than grinding. Ground barytes which is not pure white may be sold as ground barytes "off color" or "unbleached." This grade is used for dark-colored paints and as a filler by the paper industry, chiefly in the manufacture of heavy, stiff materials such as playing cards and Bristol boards. Ground barytes which is not pure white in color may be bleached by means of sulphuric acid which dissolves and removes the iron. This grade of ground barytes is known as "prime white" or "floated" barytes. It is used as a pigment in white paints and as a filler in paper, rubber goods, "artificial ivory," and for other purposes where a white, inert pigment or filler is desired.

Blanc fixe is precipitated barium sulphate produced by treating a solution of a barium salt with sodium sulphate (salt cake). This product, while having the same chemical composition, is different in physical properties from ground barytes. It is essentially a manufactured product and is therefore discussed under the barium chemical industry. (See p. 41.)

Barytes is the only domestic source of barium products. There is, however, a small quantity of witherite imported, which is used in the manufacture of barium chemicals. Witherite is a naturally occurring mineral composed chiefly of barium carbonate ($BaCO_3$). When pure it contains 77.6 per cent of barium oxide. Witherite has about the same hardness and specific gravity as barytes. It is easily decomposed by acids, which fact gives it advantages over barytes in the manufacture of certain barium chemicals. It is also used as an inert filler in the rubber industry. In England it is reported to be used chiefly for manufacturing barium chemicals, and it is also used in Germany for this purpose.

Table 1 shows the distribution of crude barytes according to the three principal consuming industries—ground barytes, lithopone, and barium chemicals. The total in this table does not necessarily correspond with the total production as some minor uses are not included and discrepancies may also be accounted for by

stocks in manufacturers' hands. The decrease in the consumption of crude barytes in 1918 is accounted for chiefly by a decrease in the quantity of crude barytes consumed in the manufacture of barium chemicals.

TABLE 1.—*Crude barytes used in the manufacture of barium products.*

[From Mineral Resources, U. S. Geological Survey.]

Calendar year.	For barium chemicals.	For ground barytes.	For lithopone.	Total.
	Short tons.	*Short tons.*	*Short tons.*	*Short tons.*
1915	10,216	53,903	44,503	108,622
1916	38,283	75,507	71,898	185,688
1917	49,842	60,132	86,065	196,039
1918	38,041	60,460	85,282	183,783
1919[1]	27,696	63,051	103,968	194,715

[1] Preliminary figures furnished by courtesy of the U. S. Geological Survey, subject to revision.

As can be seen from Table 1, the manufacture of lithopone and barium chemicals is an important outlet for crude barytes. In 1917, with a maximum consumption of crude barytes, the lithopone industry required about 43 per cent and the barium chemical industry about 25 per cent of the total quantity of crude barytes consumed in the United States. Figure 1 shows graphically the consumption of crude barytes by industries.

DOMESTIC PRODUCTION.

Production and consumption.—From 35 to 45 per cent of the domestic consumption of crude barytes prior to 1914 was imported chiefly from Germany. The imported product supplied the Atlantic coast market as it could be obtained at a cost less than that of domestic crude barytes. Prior to the war about 65 per cent of the domestic output of crude barytes was from Missouri and supplied the mid-western market for ground barytes. It has been estimated that about 50 per cent of the ground barytes manufactured in the mid-western district was prior to the war, and still is, shipped to and consumed in the Atlantic coast market. Foreign competition before the war was chiefly in crude barytes; this is evident from import statistics, which show an importation of only about one-seventh as much ground or manufactured as of crude barytes.

The great increase in the domestic production of crude barytes, beginning in the year 1915, was due partly to the cutting off of the foreign supply of barytes and barium chemicals. War conditions forced eastern manufacturers in the United States to seek a domestic supply of their raw material, and resulted in the establishment in this country of a barium chemical industry. There was also, how-

FIGURE 1 — DOMESTIC CONSUMPTION OF BARYTES BY INDUSTRIES
1915 – 1918

* 1918 - BASED ON PRELIMINARY FIGURES

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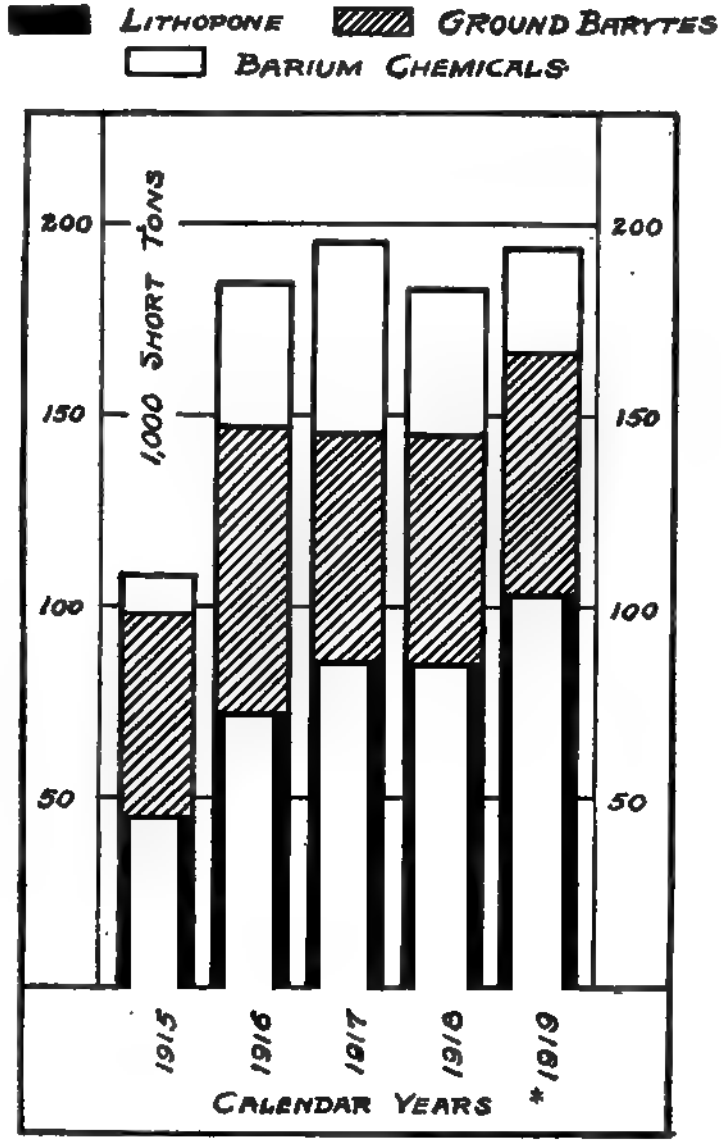
FIGURE 1 — DOMESTIC CONSUMPTION OF BARYTES BY INDUSTRIES
1915–1919



* 1919 – BASED ON PRELIMINARY FIGURES

C.W.D. 5-26-20.

ever, a natural development due to the increased demand for barytes in the manufacture of lithopone and to the greater use of ground barytes and blanc fixe, particularly in the rubber industry. This increase places the United States second as a producer of crude barytes with an output approaching that of Germany prior to the war.

The domestic output of crude barytes increased about fourfold from 1914 to 1916, or from 52,747 short tons to 221,952 short tons. The 1918 production shows a 25 per cent decrease from the output in 1917. Preliminary figures for 1919 indicate an increase in production to about 190,000 tons. Table 2 shows the domestic sales, imports, and apparent consumption of crude barytes. The same data are shown graphically in Figure 2.

TABLE 2.—*Apparent consumption of crude barytes in the United States, 1910–1919.*

[From Mineral Resources, U. S. Geological Survey.]

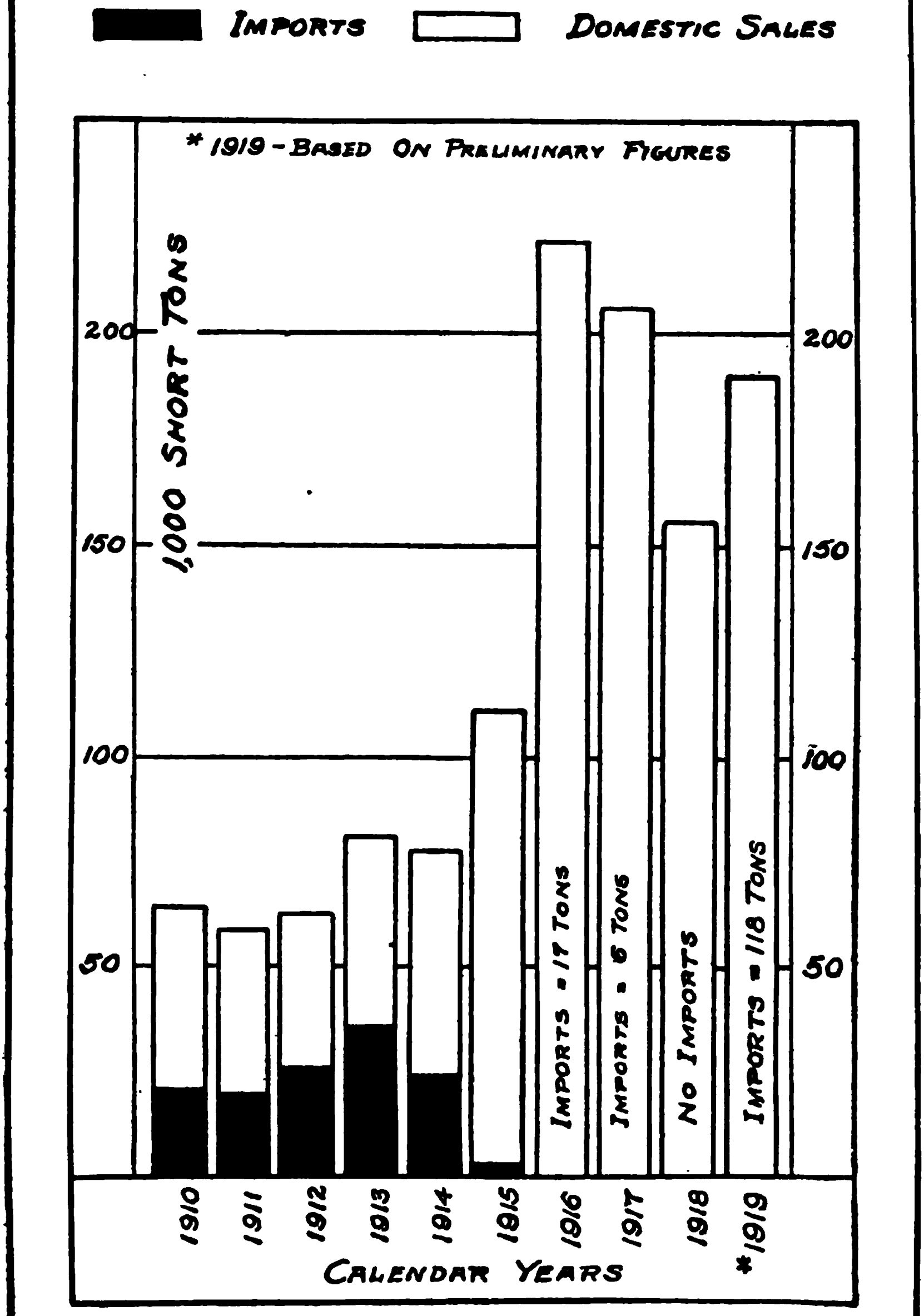
Calendar year.	Sales of domestic barytes.	Imports for consumption.	Apparent consumption.	Calendar year.	Sales of domestic barytes.	Imports for consumption.	Apparent consumption.
	Short tons.	*Short tons.*	*Short tons.*		*Short tons.*	*Short tons.*	*Short tons.*
1910.....	42,975	21,270	64,245	1915.....	108,547	2,504	111,051
1911.....	38,445	20,214	58,659	1916.....	221,952	17	221,969
1912.....	37,478	26,186	63,664	1917.....	206,888	6	206,894
1913.....	45,298	35,840	81,138	1918.....	155,368	.....	155,368
1914.....	52,747	24,423	77,170	1919.....	[1] 190,000	118	190,118

[1] Preliminary figure furnished by courtesy of the U. S. Geological Survey, subject to revision.

Geographical distribution.—Until 1915 about 65 per cent of the domestic output of crude barytes was mined in the State of Missouri. This location of the domestic barytes mining industry was due, as has been pointed out, to domination of the eastern markets by imported crude barytes. Conditions brought about by war caused a marked change in the domestic industry. In 1915 the output of crude barytes in Georgia about equaled that of Missouri, and in 1916 Georgia became the chief producing State, with a production nearly twice that of Missouri, although the production of Missouri had almost doubled. Since 1915 Georgia has contributed about 50 per cent of the total domestic production. The shifting of the greatest production of crude barytes from Missouri to Georgia was due to the cessation of imports of barytes and barium chemicals from Germany, lower freight rates to eastern factories making lithopone and barium chemicals, and the geological character of the deposits which permitted mining by means of the steam shovel.

War developments, although greatly increasing the output and consumption of crude barytes, still leave the industry divided between two distinct localities—(1) the middle western district, with Missouri as the chief producer, and (2) the southern district, repre-

FIGURE 2.—CONSUMPTION OF BARYTES IN THE UNITED STATES 1910–1919



C.R.D. 5-27-20.

sented chiefly by Georgia and to a lesser extent by Tennessee and Kentucky. The western district supplies lithopone manufacturers in the St. Louis and Chicago districts as well as local manufacturers of ground barytes who ship about one-half of their output into eastern markets. Very little crude barytes from the middle western district is shipped to eastern markets, because of disadvantages as to freight charges. The southern district supplies crude barytes to eastern manufacturers of lithopone who formerly obtained this raw material chiefly from Germany, and also supplies the requirements of the new barium chemical industry which has been developed since the beginning of the war to supply chemicals formerly obtained by importation.

Table 3 shows the production of crude barytes by States since 1910.

TABLE 3.—*Production of crude barytes, by States, 1910–1918.*

[From Mineral Resources, U. S. Geological Survey.

State.	1910		1911		1912	
	Quantity.	Value.	Quantity.	Value.	Quantity.	Value.
	Short tons		*Short tons.*		*Short tons.*	
Missouri	22,978	$75,598	21,500	$81,380	24,530	$117,035
Tennessee	6,503	13,348	8,819	20,053	3,718	8,682
Kentucky					.....	.....
All other	13,494	32,800	8,126	21,359	9,230	27,596
Total	42,975	121,746	38,445	122,792	37,478	153,313

State.	1913		1914		1915	
	Quantity.	Value.	Quantity.	Value.	Quantity.	Value.
	Short tons.		*Short tons.*		*Short tons.*	
Alabama	.....	.....	.....	.....	(1)	(1)
Colorado	.....	.....	.....	.....	(1)	(1)
Georgia	.....	.....	.....	.....	31,027	$102,825
Kentucky	.....	.....	.....	.....	7,753	28,427
Missouri	31,131	$117,638	33,317	$112,231	39,113	158,597
North Carolina	.....	.....	.....	.....	(1)	(1)
Tennessee	2,098	3,568	10,113	16,273	25,074	71,290
All other	12,069	35,069	9,317	27,143	5,580	19,793
Total	45,298	156,275	52,747	155,647	108,547	381,032

State.	1916		1917		1918	
	Quantity.	Value.	Quantity.	Value.	Quantity.	Value.
	Short tons.		*Short tons.*		*Short tons.*	
Alabama	7,631	$27,198	1,976	$8,868	1,794	$9,976
Colorado	481	3,005	.....	.....	.....	.....
Georgia	104,784	401,295	111,300	601,895	69,318	418,178
Kentucky	11,068	54,995	6,720	36,084	(1)	(1)
Missouri	58,223	365,111	59,046	391,363	49,094	393,738
North Carolina	878	3,246	1,019	5,080	(1)	(1)
Tennessee	32,416	123,986	16,972	79,058	22,542	141,844
All other	6,471	32,396	9,855	48,836	12,620	81,169
Total	221,952	1,011,232	206,888	1,171,184	155,368	1,044,905

[1] Included in "All other."

In the Missouri district crude barytes is sold on the basis of the short ton (2,000 pounds), while in the southern district the long ton (2,240 pounds) is used in all transactions in crude barytes.

Freight rates on crude barytes.[1]—The average freight rate on crude barytes from the Cartersville, Ga., district to eastern lithopone manufacturers is $4.45 per short ton. This average is made up of rates ranging from a low rate of $3.75 to Baltimore, Md., and a high rate of $4.73 to Newark, N. J., Grasselli, N. J., Newport, Del., and Palmerton, Pa.

The average freight rate from the Sweetwater, Tenn., district to eastern lithopone manufacturers is $4.47 per short ton, or practically the same as the average freight rate from the Cartersville district. This average is made up of rates varying from a minimum of $3.75 to Baltimore and a maximum of $4.82 to Newark, Grasselli, and Palmerton. Although the average freight rates from Sweetwater and Cartersville to eastern lithopone manufacturers are practically the same, there is little uniformity in rates to given points. In some cases the rate from Sweetwater is higher than the rate from Cartersville and sometimes lower.

The average freight rate from St. Louis, which may be taken as the shipping point for the Missouri district, to eastern manufacturers of lithopone, is $5.69 per short ton. This, compared with the rates from Cartersville and Sweetwater, gives the southern district an advantage in transportation charges to the eastern lithopone district of $1.24 per short ton. The difference in rates has prevented active competition between southern and western crude barytes in the eastern markets. Missouri ore, in order to compete in these markets, would have to absorb the freight differential of $1.24 in lower prices for crude barytes f. o. b. St. Louis.

Table 4 shows the freight rates on crude barytes from the principal producing points to the principal consuming points.

TABLE 4.—*Freight rates on crude barytes per short ton in carload lots.*

[Compiled from files of Interstate Commerce Commission as of May 26, 1920. Rates are current all rail and commodity rates, unless noted.]

To—	From Cartersville, Ga., minimum carload of 60,000 pounds.	From Sweetwater, Tenn., minimum carload of 60,000 pounds.	From St. Louis, Mo., minimum carload of 40,000 pounds.
Camden, N. J.	$4.29	.....	$5.60
Newark, N. J.	4.73	$4.82	6.00
Grasselli, N. J.	4.73	4.82	6.00
Newport, Del.	4.73	4.29	5.60
Baltimore, Md.	3.75	[2] 3.75	5.40
Palmerton, Pa.	4.73	4.82	5.60
Chicago, Ill.	[3] 5.54	[4] 4.46	2.10
Philadelphia, Pa.	4.29	4.29	5.60

[1] Rates used in this discussion obtaining on May 26, 1920.
[2] From Reagan, Tenn.
[3] Ohio River combination.
[4] Minimum carload weight 44,800 pounds.

Extent of barytes deposits in the United States.—One of the questions of principal importance in considering a duty on barytes is the extent and availability of deposits in the United States. Under the stimulus of war conditions the production of barytes in the United States increased fourfold from 1914 to 1916, and supplied the entire domestic consumption. But there is very little definite information as to the extent of the deposits, and owing to the general nature of the deposits it would be practically impossible to arrive at any accurate estimate of the total domestic barytes resources.

In the absence of official governmental information on the barytes resources of the United States, the Tariff Commission sent out questionnaires to both producers and consumers of barytes requesting information on the extent of domestic deposits. There developed a distinct cleavage of opinion between the two interested groups. The question submitted on the subject was as follows:

For what length of time do you consider that the barytes resources of the United States are capable of supplying the total domestic requirements? Give your reasons.

Manufacturers of lithopone, the largest consumers of barytes, estimated the life of deposits which are being worked at the present time from a minimum of two years to a maximum of seven years. Lithopone manufacturers were supplied prior to the war with German barytes at a cost less than that of domestic barytes. The following statements are taken from consumers' replies to the above question:

"A careful review of the different mining sections in the East leads us to believe that the new developed barytes resources are capable of supplying the domestic requirements for not more than two years."

"From five to seven years. This statement is made after a rather exhaustive study of the various barytes producing districts and spending of considerable money in exploration work, and it is believed that practically all of the commercial deposits have been uncovered."

"At present rate of consumption the known higher grade deposits of to-day will be exhausted in from three to five years. Low-grade ores (90 per cent $BaSO_4$) if they can be made suitable, which is questionable, could supply the markets for a longer period (5 to 10 years)."

On the other hand barytes producers state that domestic deposits can supply the demand for an indefinite period. The following replies are quoted from producers of barytes:

"In the writer's opinion the answer to this question as it stands would be 'indefinitely,' provided the proper stimulus was given. Barytes is one of the most widely distributed mineral substances that we know of. There has, however, up to the last few years been no incentive for the development of American resources, at least in what might be called the eastern seaboard district."

"The fact that several properties have been worked for 15 years past, and are now only developed to a good working basis and are known to be good for 15 to 20 years to come assures us that we are safe as to our supply."

"Unlimited supply in Missouri fields * * *. Portions that have been producing for the past 40 years are still yielding good tonnage, and geologists estimate that the surface ore has only been touched and that heavier deposits lie deeper."

The possibility of increasing the production of barytes is more promising in Georgia and Tennessee than in the Missouri district. The first two districts seem to contain large quantities of ore and could probably be developed to a point where they would supply an increased demand of eastern manufacturers.

Owing to geological and geographical disadvantages, the known domestic deposits in the southern district will probably not be able to compete on even terms in the Atlantic coast market with barytes imported from Germany. The German deposits are of vein formation and require only drilling and blasting to make the ore available for shipment. The known domestic deposits, on the other hand, are of such a character that the ore-bearing material, after mining, requires washing and mechanical separation from foreign rock material—a process which involves additional equipment—before the ore is ready to be marketed as crude barytes. Prior to the war the freight rate from German mines to Atlantic ports was about $3 per ton as compared with the freight rate from Georgia and Tennessee to the eastern markets of about $4.45 a ton. In view of the difference in mining methods and the difference in freight rates, it would appear that competition would be difficult under normal conditions.

In considering a duty on barytes the extent to which the cost of crude barytes enters into the cost of manufactured products should also be taken into account. (See pp. 72 and 87 for further discussion of this phase of the subject.) From the cost figures the effect which a decrease or increase in the cost of barytes would have on the total cost of a particular product can be determined.

PRODUCTION OF BARYTES IN FOREIGN COUNTRIES.

Germany.—Germany has large deposits of crude barytes of an exceedingly good grade and prior to the war was the largest producer of barytes and of barium chemicals. In 1913 she exported 174,235 short tons or nearly four times as much as was produced the same year in this country and three times as much as was produced in the United Kingdom. Her production of crude barytes during 1908 was about 210,000 metric tons (231,000 short tons) valued at around 2,000,000 marks (about $500,000).[1] The exports of Germany as shown by Table 5 increased about 75,000 short tons from 1909 to 1913. This indicates a growth of her output, so it is reasonable to assume that Germany's production of crude barytes just prior to the war was at least 300,000 short tons. The production in the United States during the war increased to a maximum of 221,952 short tons in 1916.

[1] Bartling, Dr. Richard: "[illegible]atlagerstaten Deutschlands," 1911.

which gives the United States an output second only to that of Germany.

Table 5, which shows the German exports and imports of barytes and celestite (natural strontium sulphate, which is relatively unimportant in quantity), is indicative of the growth of the industry in that country.

TABLE 5.—*Germany's exports and imports of barytes and celestite.*[1]

[From Vierteljahrshefte zur Statistik des Deutschen Reichs.]

Year.	Exports.		Imports.	
	Short tons.	Value.	Short tons.	Value.
1909	93,819	$705,310	16,049	$104,093
1910	125,962	787,489	6,373	41,209
1911	141,512	788,(80,	8,737	56,692
1912	157,581	992,818	20,575	133,392
1913	174,235	1,058,084	21,457	139,109

[1] Celestite is naturally occurring strontium sulphate. It is relatively unimportant in quantity compared with barytes so that figures may be taken for all practical purposes as representing barytes.

United Kingdom.[2]—The United Kingdom in 1919 ranked third in the production of crude barytes. In 1913 her production exceeded that of the United States by about 10,000 tons. Production, however, has increased during the war more rapidly in the United States than in the United Kingdom, so that the output in this country in 1917 was almost three times that of Great Britain. The United Kingdom, in addition to having large and valuable deposits of barytes, possesses deposits of witherite (barium carbonate) which can be mined economically. The total annual output of witherite in the United Kingdom since 1880 has varied between 6,000 and 12,000 short tons, the maximum output occurring in 1910. Table 6 gives the production, value at mine, and unit value of crude barytes and witherite produced in the United Kingdom.

TABLE 6.—*Production of barytes and witherite in the United Kingdom.*[3]

Year.	Quantity (short tons).	Value at mine.	Unit value per short ton.	Year.	Quantity (short tons).	Value at mine.	Unit value per short ton.
1900	32,901	$142,316.00	$4.31	1910	$50,027	$213,683.00	4.27
1901	30,927	135,337.00	4.38	1911	49,412	196,538.00	3.98
1902	23,441	109,078.00	4.13	1912	50,822	191,886.00	3.78
1903	27,184	108,620.00	4.00	1913	56,050	205,055.00	3.66
1904	23,486	120,071.00	4.07	1914	54,802	211,722.00	3.86
1905	32,551	144,136.00	4.43	1915	69,974	388,488.00	5.55
1906	40,034	171,700.00	4.29	1916	85,158	620,435.00	7.29
1907	47,011	187,068.00	3.98	1917	73,424	687,797.00	9.37
1908	43,621	171,403.00	3.93	1918	74,323	(4)	(4)
1909	46,778	197,230.00	4.22				

[1] Abstracted from the following official publications of the United Kingdom: Report of the Controller of the Department for Development of Mineral Resources in the United Kingdom, 1918, Cd. 9184; and Carruthers, R. G. et al., Special Reports on the Mineral Resources of Great Britain, Vol. II.—Barytes and Witherite, Memoirs of the Geological Survey of Great Britain.

[2] From Mines and Quarries, Part III, Geenral Report, with Statistics by Chief Inspector of Mines, Home Office of Great Britain.

[4] Value not available.

The normal annual requirements for crude barium mineral in the United Kingdom amounted to about 100,000 tons. Of this quantity, in normal times, about 60 per cent was imported, chiefly from Germany. Prior to the war little attention was given in the United Kingdom to the proper treatment of the raw barytes. The result was the domination of the British market by Germany, who produced a grade of superior quality as to whiteness and fineness of grinding. Prior to the war the best grade of German ground barytes sold at about 50 shillings ($12.16), and the second grade at 30 shillings ($7.30) per ton delivered in London. A product equal in quality to that formerly imported into the United Kingdom is now being supplied by English manufacturers. A conservative estimate places the quantity of high-grade barytes ore "in sight" in 1918 in the United Kingdom at 500,000 tons, which is equivalent to a five-year supply. There are, however, many large and undeveloped deposits in both England and Ireland, so that requirements of the United Kingdom can be supplied for many years.

About 70 per cent of the barytes consumed in the United Kingdom is used in the manufacture of lithopone and paints. The remainder is used in paper, rubber, and linoleum manufacture. Witherite is used chiefly by chemical manufacturers in the production of barium chemicals.

Table 7 gives the production, imports, exports, and apparent consumption of barytes in the United Kingdom:

TABLE 7.—*Apparent consumption of barytes in the United Kingdom.*

Calendar year.	Production.	Imports.[1]	Exports.[1]	Apparent consumption.
	Short tons.	*Short tons.*	*Short tons.*	*Short tons.*
1910	50,027	50,876	12,874	88,029
1911	49,412	54,054	9,432	94,034
1912	50,822	64,412	9,933	105,301
1913	56,050	61,188	6,425	110,813
1914	54,802	35,379	3,337	86,844
1915	69,974	7,937	2,748	75,163
1916	85,158	10,343	4,733	90,768
1917	73,424	1,566	4,207	70,783
1918	74,323	1,658	1,757	74,224
1919	.....	22,972	1,360	.....
1920 (5 months)	.....	13,271	317	.....

[1] From the Annual Statement of the Trade and Commerce of the United Kingdom.

Other foreign countries.[2]—Other foreign countries which produce barytes in appreciable quantities are Belgium, Spain, France, and Italy. The output of Belgium has varied considerably, but may be taken as between 20,000 and 30,000 tons. The production of Italy increased during the war from 13,000 tons in 1914 to about 19,000 tons in 1917. The production of France prior to the war was about

[2] Figures of production from Mineral Industry, New York, 1918.

12,000 tons; statistics for later years are not available. The output of barytes in Spain increased from 4,000 tons in 1915 to about 10,000 tons in 1917.

IMPORTS INTO THE UNITED STATES.

The imports of crude barytes were increasing prior to the war, and in 1914 amounted to 36,456 short tons, valued at $63,260. The imports of ground or manufactured barytes were considerably less and in 1914 had reached 6,026 short tons, valued at $42,625. Imports, which were almost wholly from Germany, were shut off with the outbreak of the war, and there have been practically no imports of barytes since 1915.

Tables 8 and 9 show the imports for consumption of crude and ground barytes since 1910.

TABLE 8.—*Imports of crude barytes for consumption in the United States, 1910–1919.*

[Baryta, sulphate of, or barytes, including barytes earth, unmanufactured.]

Fiscal year.	Rate of duty.	Quantity (short tons).	Value.	Duty collected.	Value per unit of quantity.	Actual and computed ad valorem rate.
						Per cent.
1910[1]	75 cents per ton	2,500	$10,824	$1,674	$4.33	15.47
1910[2]	$1.50 per ton	9,395	21,286	12,582	2.27	59.11
1911	do	20,602	45,06.	27,592	2.19	61.23
1912	do	23,507	40,941	31,482	1.74	76.90
1913	do	31,761	63,345	42,537	1.99	67.15
1914[3]	do	6,680	12,313	8,946	1.84	72.65
1914[4]	15 per cent. ad valorem	29,776	50,947	7,642	1.71	15.00
1915	do	10,770	21,087	3,163	1.96	15.00
1916	do	17	245	37	14.41	15.00
1917	do	.....	.....	.....	.....	.....
1918	do	6	63	9	10.50	15.00
1919	do	39	245	37	6.28	15.00

[1] From July 1 to Aug. 5, 1909.
[2] From Aug. 6, 1909, to June 30, 1910.
[3] From July 1 to Oct. 3, 1913.
[4] From Oct. 4, 1913, to June 30, 1914.

TABLE 9.—*Imports of ground barytes for consumption in the United States, 1910–1919*

[Baryta, sulphate of, or barytes, including barytes earth, manufactured.]

Fiscal year.	Rate of duty.	Quantity (short tons).	Value.	Duty collected.	Value per unit of quantity.	Actual and computed ad valorem rate.
						Per cent.
1910	$5.25 per ton	3,023	$27,191	$14,169	$8.99	52.11
1911	do	3,655	26,462	17,131	7.24	64.74
1912	do	3,012	21,642	14,117	7.19	65.23
1913	do	5,145	36,819	24,119	7.16	65.51
1914[1]	do	1,107	7,520	5,184	6.79	68.94
1914[2]	20 per cent ad valorem	4,919	35,105	7,021	7.14	20.00
1915	do	1,966	14,997	2,999	7.63	20.00
1916	do	.....	2	.....	.....	20.00
1917	do	235	3,813	763	16.23	20.00
1918	do	.....	.....	.....	.....	20.00
1919	do	.....	.....	.....	.....	20.00

[1] From July 1 to Oct. 3, 1913.
[2] From Oct. 4, 1913, to June 30, 1914.

PRICES.

United States.—The average dutiable value of crude barytes imported from 1912 to 1915, inclusive, was $1.85 per short ton, as shown by import statistics. Information from consular invoices shows that the prewar price of crude barytes was about $1.75 per short ton f. o. b. German mines. Freight charges from the mine to Atlantic ports made the price of crude barytes about $4.70 per short ton ex ship at New York or Philadelphia. To this price must be added the duty under the act of 1913 and barge or switching charge to eastern consumers, so that the price delivered at plants was about $5.20 per short ton. This price varied somewhat according to individual conditions, but the figures given may be taken as an average. Table 10 shows the detail of the price of imported crude barytes for 1914:

TABLE 10.—*Average price per short ton of crude barytes imported from Germany,*[1] *1914.*

Price f. o. b. mine	$1.75
Railroad and river freight to Rotterdam	1.20
Ocean freight	1.75
Price ex ship New York or Philadelphia (duty not paid)	4.70
Price delivered at plants on Atlantic coast[2]	5.20

The price of domestic crude barytes f. o. b. St. Louis has about doubled during the war. The price from May, 1913, until November, 1915, varied very little from $4.90 per short ton. The price then increased to $9.80 per ton in October, 1918, and this price was in force until May, 1919, when it decreased to $8.80 per ton. In November, 1919, the price increased sharply to $10.80 per ton. Table 11 shows the market price of crude barytes per short ton f. o. b. Missouri shipping points.

TABLE 11.—*Market price of crude barytes f. o. b. Missouri shipping points.*

[Dollars per short ton.]

Date.	Washington County, Mo., district.	St. Louis, western Missouri district.
1912, January to October	$4.25	$4.90
1912, October to December, inclusive	5.50	6.15
1913, January to May	7.00	7.65
1913, May to December, inclusive	4.25	4.90
1914, entire year	4.25	4.90
1915, January to November	4.25	4.90
1915, November and December	4.50	5.15
1916, January	4.50	5.15
1916, February and March	5.00	5.65
1916, April to December, inclusive	7.00	7.65
1917, entire year	7.00	7.65
1918, January to August	7.00	7.80
1918, August and September	8.00	8.80
1918, October to December, inclusive	9.00	9.80
1919, January to May	9.00	9.80
1919, May to November	8.00	8.80
1919, November and December	10.00	10.80
1920, January to April	10.00	10.80

[1] From consular invoices of individual shipments.

[2] Includes duty under the act of 1913 and barge or switching charge to plant.

Contract prices on Missouri ground barytes f. o. b. St. Louis have not increased in the same ratio as crude barytes. Table 12 shows contract prices of ground barytes f. o. b. St. Louis in carload shipments.

TABLE 12.—*Contract price of Missouri ground barytes f. o. b. St. Louis in carload shipments.*

Year.	Per short ton.	Year.	Per short ton
1912	$13.00	1917	$19.00
1913	15.50	1918	19.00
1914	13.00	1919	21.50
1915	13.00	1920	21.50
1916	13.00		

The price of crude barytes f. o. b. Cartersville, Ga., increased from $4.25–$6.00 per short ton in 1916 to $8.95 per short ton in the first half of 1920. The price of ground barytes f. o. b. Cartersville has been more constant than that of crude barytes. The price of ground barytes was $17.85 per short ton from 1916 to 1918, inclusive, and then increased to $18.75 in 1919 and the first part of 1920. Table 13 shows the price of crude and ground barytes f. o. b. Cartersville, Ga., since 1916:

TABLE 13.—*Prices of crude and ground barytes per short ton f. o. b. Cartersville, Ga.*

Year.	Crude.	Ground.
1916	$4.25–$6.00	$17.85
1917	4.90– 6.70	17.85
1918	6.45– 8.00	17.85
1919	7.35– 8.95	18.75
1920	8.95	18.75

United Kingdom.—Price quotations on crude barytes in the United Kingdom are not available. Table 6, which gives the production of crude barytes in the United Kingdom shows an average reported value of $3.86 per short ton in 1914, which increased to $9.37 in 1917, the latest year for which complete statistics are available. The increase in the price of ground barytes in the United Kingdom during the war was about in the same proportion as in this country. The increase, however, began in 1912 and shows a gradual trend upward from that time, while the increase in price in the United States did not begin until 1916. The price in the United Kingdom has usually been lower than the price in this country. Table 14 shows the price of ground barytes by quarters in the United Kingdom as quoted by the Chemical Trade Journal and Chemical Engineer of London.

TABLE 14.—*Price of ground barytes in the United Kingdom, 1910–1919; per short ton.*[1]

1910—January	$9.77–$14.12	1915—January	$16.29–$19.55
April	9.77– 14.12	April	17.38– 20.63
July	9.77– 14.12	July	18.46– 21.72
October	9.77– 14.12	October	19.55– 26.06
1911—January	9.77– 14.12	1916—January	19.55– 26.06
April	9.77– 14.12	April	19.55– 26.06
July	9.77– 14.12	July	19.55– 32.58
October	9.77– 14.12	October	19.55– 32.58
1912—January	9.77– 14.12	1917—January	19.55– 32.58
April	9.77– 14.12	April	21.72– 36.92
July	10.86– 14.12	July	21.72– 36.92
October	10.86– 14.12	October	21.72– 36.92
1913—January	11.95– 16.29	1918—January	21.72– 36.92
April	13.03– 16.29	April	30.41– 60.83
July	13.03– 16.29	July	30.41– 60.83
October	13.03– 16.29	October	39.10– 65.18
1914—January	13.03– 16.29	1919—January	39.10– 65.17
April	13.03– 16.29	April	39.10– 65.1.
July	13.03– 16.29	July	30.42– 60.83
October	16.29– 19.55	October	30.42– 60.83

[1] Taken from Chemical Trade Journal and Chemical Engineer, London. Listed as barium sulphate, native levigated, f. o. r. at works or usual ports of shipment.

Germany.—Barytes is not regularly quoted in German chemical trade journals. The following prices are offerings of crude and ground barytes, which were received by American firms from German firms.[1] The prices quoted in these letters are tabulated and converted in Tables 15 and 16 at the par value of the mark and at the exchange value of the mark on the date the letters were written.

TABLE 15.—*Prices of crude barytes, free Hamburg or Bremen, Oct. 21, 1919.*

Grade.	Price per short ton.		
	Marks.	Mark = $0.2382.	Mark = $0.036.
No. 1 = 98 to 99 per cent	65	$15.48	$2.34
No. 2 = 95 to 96 per cent	60	14.29	2.16

TABLE 16.—*Price of crude barytes, free Bremen, Hamburg, or Rotterdam, Sept. 30, 1919.*

Brand.	Class.	Price.		
		Marks per metric ton.	Dollars per short ton.	
			Mark = $0.2382.	Mark = $0.04.
S W O O O	1	329.5	$71.20	$11.96
Lowe	3	318.5	68.83	11.56
Adler	6	304.5	65.80	11.05
G O O O	8b	292.5	63.21	10.61

[1] Original letters in files of the Tariff Commission.

COMPETITIVE CONDITIONS.

The situation prior to the war.—The Atlantic coast market for crude barytes was supplied exclusively by imports, chiefly from Germany, amounting to between 35 and 45 per cent of the total domestic consumption of crude barytes. The interior points at which imported barytes could compete with the domestic ore produced in Missouri depended wholly on the cost of transportation or freight rates to the market in question. The outlet for domestic crude barytes prior to the war was thereby restricted to supplying the middle western manufacturers of ground barytes, while the imported crude barytes was consumed almost wholly by eastern manufacturers of lithopone.

This division of the domestic market did not exist in the case of ground barytes. Under the duties in the act of 1909 for ground or manufactured barytes ($5.25 per ton), domestic ground barytes was able to compete in the Atlantic coast market with imported ground barytes. It is estimated that prior to the war about 50 per cent of the ground barytes manufactured in the Middle West was shipped to and consumed in the Atlantic coast market. The imports of ground or manufactured barytes prior to the war were only about 15 per cent of the imports of crude barytes, which shows that the competition between domestic and foreign barytes was chiefly in the crude ore. Table 17 shows the imports of ground and crude barytes for 1911 to 1913, inclusive.

TABLE 17.—*Comparison of imports of crude and ground barytes, 1911–1913.*

Fiscal year.	Ground barytes.	Crude barytes.
	Short tons.	*Short tons.*
1911	3,655	20,602
1912	3,012	23,507
1913	5,145	31,761

The present situation.—The deposits of barytes in the southern district have an advantage over Missouri deposits of about $1.25 per short ton in freight rates to the Atlantic coast market. War conditions have therefore not changed the competitive situation as far as middle western producers of crude barytes are concerned. With normal conditions restored competition in crude barytes in the Atlantic coast market will be between the foreign product and domestic crude barytes produced in Georgia, Tennessee, and Kentucky; crude barytes produced in Missouri will not be able to compete in this market even under existing conditions.

In the matter of ground barytes, however, the manufacturers in the Middle West continue to ship about 50 per cent of their product

to the Atlantic coast market. Although ground barytes from the southern district has a lower freight rate to Atlantic coast markets than Missouri ground barytes, the Missouri product still supplies a large portion of this market. This may be explained by the fact that eastern lithopone and barium chemical manufacturers developed the southern deposits chiefly to supply their raw-material requirements. Missouri barytes is a softer variety and is better adapted for the manufacture of ground barytes than is the southern ore. It is evident that the producers of crude barytes in the southern district are particularly interested in retaining the Atlantic coast market for crude barytes while the Missouri producers and manufacturers of ground barytes are more interested in being able to hold this market for ground barytes, which they largely supplied prior to the war.

TARIFF HISTORY.

Barytes or barium sulphate, unmanufactured or manufactured, has been dutiable since the passage of the act of 1883, with the exception of the period covered by the act of 1894, when barytes unmanufactured, including barytes earth, was free of duty. Witherite (natural barium carbonate) has uniformly been exempt from duty since 1883. The duties levied on barytes, unmanufactured and manufactured, and the provisions for witherite beginning with the act of 1883 are as follows:

Act of—	Paragraph.	Tariff classification or description.	Rates of duty, specific and ad valorem.
1883.....	40	Baryta, sulphate of, or barytes, unmanufactured.....	10 per cent ad valorem.
1883.....	41	Baryta, sulphate of, or barytes, manufactured.....	¼ cent per pound.
1883.....	603	Baryta, carbonate or witherite.....	Free.
1890.....	49	Baryta, sulphate of, or barytes, including barytes earth:	
		Unmanufactured.....	$1.12 per ton.
		Manufactured.....	$6.72 per ton.
1890.....	500	Baryta, carbonate of, or witherite.....	Free.
1894.....	37	Baryta, sulphate of, or barytes, manufactured.....	$3 per ton.
1894.....	395	Baryta, carbonate of, or witherite, and baryta, sulphate of, or barytes, unmanufactured, including barytes earth.	Free.
1897.....	44	Baryta, sulphate of, or barytes, including barytes earth:	
		Unmanufactured.....	75 cents per ton.
		Manufactured.....	$5.25 per ton.
1897.....	489	Baryta, carbonate of, or witherite.....	Free.
1909.....	42	Baryta, sulphate of, or barytes, including barytes earth:	
		Unmanufactured.....	$1.50 per ton.
		Manufactured.....	$5.25 per ton.
1909.....	711	Witherite.....	Free.
1913.....	51	Baryta, sulphate of, or barytes, including barytes earth:	
		Unmanufactured.....	15 per cent ad valorem.
		Manufactured.....	20 per cent ad valorem.
1913.....	646	Witherite.....	Free.

CONSTRUCTION OF THE LAW.

In a case under the act of 1894 in which the importers furnished no evidence to support their protest, ground carbonate of baryta was held dutiable as an unenumerated manufactured article and not

exempt from duty as native or unmanufactured carbonate of baryta or witherite of commerce. (G. A. 3622, T. D. 17483.) Under the act of 1897 which removed the limitation to carbonate of baryta in its unmanufactured condition, ground carbonate of baryta was held exempt from duty. (G. A. 4243, T. D. 19947.) In a court decision likewise classifying precipitated carbonate of baryta, paragraph 489 of the act of 1897 was declared not limited to the particular kind of carbonate of baryta known as witherite, but included all carbonates of baryta whether or not known by the name of witherite. (Gabriel & Schall *v.* United States, 121 Fed., 208; followed by the Board of General Appraisers in G. A. 5314, T. D. 24331, and G. A. 7141, T. D. 31145.) A like conclusion was reached by the Court of Customs Appeals. (United States *v.* Gabriel & Schall, 1 Ct. Cust. Appls., 90.) The provision for "witherite" in paragraph 711 of the act of 1909 was, however, declared to be limited to the natural crude mineral ore and not inclusive of precipitated carbonate of baryta, which, being a chemical salt, was held dutiable under paragraph 3 of that act. (G. A. 7262, T. D. 31810.)

PART III

THE BARIUM CHEMICAL INDUSTRY

PART III.

THE BARIUM CHEMICAL INDUSTRY.

DESCRIPTION AND USES.

The term "barium chemicals" is used in this report to include various barium salts or compounds which are manufactured by chemical processes from the barium minerals, barytes and witherite.

Blanc fixe or artificial sulphate of barytes, as it is described in the tariff act of October 3, 1913, is barium sulphate which has been precipitated from a solution of a soluble barium salt by means of a sulphate, usually salt cake. The term "blanc fixe," which means permanent white, is generally used in commerce to designate this article. The term "precipitated barium sulphate" describes the product much more accurately than artificial sulphate of barytes. As the term "barytes" alone signifies barium sulphate, the phrase "sulphate of barytes" is redundant. Blanc fixe is the best grade of barium sulphate for pigment purposes, both as to whiteness and fineness of the product. In chemical composition blanc fixe is practically identical with natural ground barytes, but its physical properties are different. The two products should not be confused. Blanc fixe is largely used where a pure white pigment or filler is desired, as in paints, rubber goods, linoleum, oilcloth, and glazed paper. It is also used in lithographic inks, as a base for lake colors, and is used extensively as a pigment by the United States Navy in "battleship gray," which contains about 45 per cent of blanc fixe. Blanc fixe under the name of chemically pure barium sulphate is used as an indicator in X-ray photography. It is placed on the market in pulp and as a dry powder. The pulp is a paste containing about 30 per cent of water and is used chiefly by the paper and lithographic ink manufacturers. The dry powder is used for pigment purposes.

Barium carbonate is a white insoluble barium salt prepared by precipitation from a solution of barium sulphide with soda ash. Its largest use is in the ceramics industry for the manufacture of optical glass, for which purpose a chemically pure product is required. Recently it has assumed importance in the manufacture of flat wall paints, and this use will undoubtedly increase. These

paints when containing about 45 per cent of precipitated barium carbonate produce a velvety finish. Witherite (natural barium carbonate) can not be used for this purpose and should not be confused with precipitated barium carbonate. It is also used as the raw material for making barium peroxide and in the manufacture of some kinds of enameled iron ware.

Barium chloride is a white barium salt which is fairly soluble in water. It crystallizes with two molecules of water and is usually sold in the crystalline or powdered form. It is largely used in the manufacture of blanc fixe and of color lakes as a mordant for fixing acid dyes on the inert base, such as aluminum hydroxide or blanc fixe. Barium chloride is also used in the purification of salt, as a water softener, a chemical reagent in sulphur determinations, to some extent in the ceramics industry, and in the manufacture of certain photographic chemicals. It has certain medicinal uses.

Barium nitrate is a soluble barium salt used principally for making barium peroxide or dioxide. It is also used in pyrotechnics for making green fire and green signal lights and in the manufacture of certain explosive mixtures, thus giving barium nitrate some military significance. It also has certain medicinal uses similar to barium chloride.

Barium monoxide or baryta has its chief use as an intermediate product in the preparation of the binoxide or peroxide of barium. It is also used in the manufacture of certain varieties of optical glass. In European countries, especially Germany, it is used in refining beet sugar.

Barium hydroxide, hydrate of baryta, or caustic baryta, has very little commercial use in the United States. During the period of high prices for caustic potash, barium hydroxide was used to convert sulphate of potash into caustic potash. In Europe it is used with barium monoxide in the refining of beet sugar.

Barium binoxide, barium dioxide, or barium peroxide, is used chiefly for the manufacture of hydrogen peroxide. It is also used for the production of oxygen and as a bleach, especially in the blanket and straw hat industries. Large quantities of hydrogen peroxide were required for war purposes. This demand and the use of barium peroxide in tracer bullets resulted in a large increase in production.

Barium sulphide is the intermediate barium compound from which the majority of the other barium chemicals are made and is one of the necessary materials in the manufacture of lithopone. It is also used with lime as a depilatory in leather manufacture. Crude barium sulphide, which is made by roasting barytes with coal, is known as "black-ash."

Barium chromate or lemon yellow, or yellow ultramarine, is used as a yellow pigment.

Barium chlorate is used in pyrotechnics and in dyeing.

DOMESTIC PRODUCTION.

Production and consumption.—Prior to the war the United States was almost wholly dependent on imports for its supply of barium chemicals. There was practically no domestic production of the barium salts such as barium dioxide, chloride, nitrate, and blanc fixe. The only product manufactured in this country on a large scale prior to the war, which utilized barytes as a raw material, was lithopone, which is discussed on pages 53–60.

The shutting off of imports with the outbreak of the war gave a great stimulus to the establishment of a barium chemical industry in the United States. In addition there were large war demands for certain barium salts (barium peroxide, blanc fixe, and barium nitrate) which greatly increased the domestic production and tended to develop an industry in the United States. Plants for the manufacture of barium salts have been located chiefly in the eastern and southern sections of the United States. The southern plants are located in close proximity to the raw material barytes. There are also plants located in Ohio and Illinois. The following is a list of the principal manufacturers of barium chemicals in the United States:

Alton Chemical Corporation, Alton, Ill.
Chicago Copper & Chemical Co., 111 West Jackson Boulevard, Chicago, Ill.
Consolidated Chemical Products Co., Alton, Ill.
Durex Chemical Corporation, 320 Fifth Avenue, New York City. (Plant at Sweetwater, Tenn.)
E. I. du Pont de Nemours & Co., Wilmington, Del.
J-H-R. Products Co., Willoughby, Ohio.
Oakland Chemical Co., 10 Astor Place, New York City.
Rollin Chemical Corporation, 120 Broadway, New York City. (Plant at Charleston, W. Va.)

The production of barium chemicals has increased steadily from 17,646,000 pounds in 1915 to 46,372,000 pounds in 1918. Preliminary figures furnished by the Geological Survey indicate a total production of barium chemicals during 1919 of about 41,500,000 pounds. The order of the barium salts according to quantity of production during 1918 was blanc fixe, barium carbonate, and barium chloride. Table 18 shows the domestic output of barium chemicals, beginning with 1915.

TABLE 18.—*Production of barium chemicals in the United States, 1915–1918.*

[From Mineral Resources, United States Geological Survey.]

	1915	1916	1917	1918
	Pounds.	*Pounds.*	*Pounds.*	*Pounds.*
Barium binoxide	(1)	3,960,000	(1)	(1)
Barium carbonate	5,492,000	13,688,000	16,476,000	15,322,000
Barium chloride	4,212,000	7,286,000	9,740,000	9,060,000
Barium nitrate	1,942,000	892,000	330,000	(1)
Barium sulphate or blanc fixe	(1)	6,674,000	12,628,000	19,044,000
All others	6,000,000	1,084,000	5,832,000	2,946,000
Total	17,646,000	33,584,000	45,006,000	46,372,000

[1] Included in "All others."

Process of manufacture.—Barytes is the raw material used in the United States for the manufacture of barium chemicals with the exception of a small quantity of witherite which is imported. A deposit of witherite was discovered in California in 1914, but it has not proved to be of commercial importance.

The manufacturers of barium chemicals prefer to use the washed, high-grade barytes of the soft type, but they can and do use the barytes which could not be used in the preparation of the highest grades of ground barytes. The crude barytes is first crushed and mixed with the proper proportions of pulverized coal. The proportion of barytes and coal varies slightly with individual manufacturers; it is generally one part of coal to four parts of barytes by weight. This mixture is roasted for about four hours in a rotating reduction furnace. The barium sulphate is reduced by the coal to barium sulphide during the roasting. The crude barium sulphide (black ash), which contains about 70 per cent of barium sulphide, is then treated with hot water and a solution of barium sulphide is thereby formed. This solution is used as the starting point for the preparation of the barium chemicals and also in the manufacture of lithopone. (See p. 54.)

Barium carbonate is precipitated from a solution of barium sulphide by treatment with sodium carbonate (soda ash). Sodium sulphide is obtained as a by-product. It can also be prepared by passing a current of carbon dioxide gas through the solution of barium sulphide. By this last process, sodium sulphide is not obtained as a by-product.

The method of producing *blanc fixe* or precipitated barium sulphate depends on the physical properties which are desired for the finished product. It was formerly made only by treating a solution of barium chloride with sodium sulphate or sulphuric acid. It is now usually made by precipitation from a solution of barium sulphide by means of salt cake (sodium sulphate). This method produces a much denser product than that produced from barium chloride, and in addition yields sodium sulphide as a valuable

by-product. It is also made as a by-product of the manufacture of hydrogen peroxide when barium peroxide is treated with sulphuric acid. For certain color purposes blanc fixe is precipitated from hot,

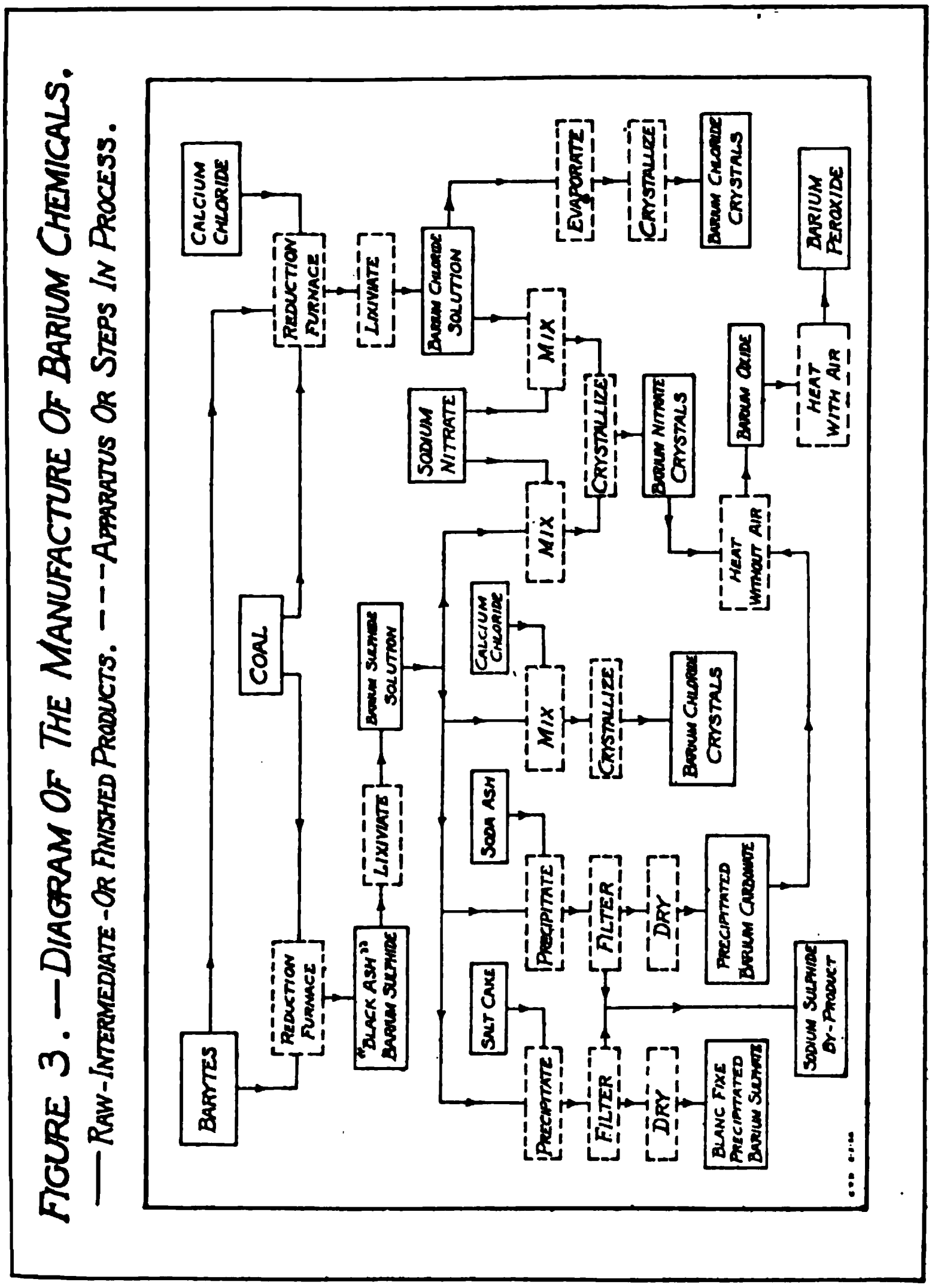


FIGURE 3.—DIAGRAM OF THE MANUFACTURE OF BARIUM CHEMICALS.
—RAW-INTERMEDIATE-OR FINISHED PRODUCTS. - - -APPARATUS OR STEPS IN PROCESS.

concentrated solutions, thus giving a crystalline product which is a valuable base for the manufacture of very brilliant colors.

Barium chloride may be produced by treating witherite (barium carbonate) with hydrochloric acid. It is usually produced in this country directly from crude barytes by roasting with coal and calcium chloride. It may also be prepared by treating a solution of barium sulphide with calcium chloride.

Barium nitrate is produced by adding sodium nitrate (Chile saltpeter) either to a solution of barium chloride or to a solution of barium sulphide. It is also produced by dissolving witherite in a solution of nitric acid. The barium nitrate thus produced can be converted into barium oxide, dioxide, or hydroxide.

Barium chromate is prepared by treating a solution of barium chloride or other soluble barium salts with sodium chromate.

Barium peroxide or dioxide is prepared from either barium nitrate or barium carbonate. The barium nitrate or carbonate is first converted into barium oxide by heating in a closed apparatus. The barium oxide is then converted into barium peroxide by heating at about 700° C. in a current of air free from carbon dioxide and moisture.

Whenever a sodium salt is added to a solution of barium sulphide in the preparation of barium salts there is produced, in addition to the desired barium product, sodium sulphide as a valuable by-product. This is an important product of the barium chemical industry, and has a large consumption by the American dye industry in the preparation of sulphur colors, especially sulphur black, which is used in large quantities.

FOREIGN PRODUCTION.

Although statistics are not available on the production of barium chemicals in foreign countries, it is undoubtedly true that Germany was the largest single producer prior to the war. England, France, and Italy possessed smaller barium chemical industries, and the industries in these countries have also been stimulated by war conditions which prevented exports of barium products from Germany. Table 19, which shows Germany's exports and imports of barium chemicals, indicates the importance of the German industry prior to the war.

TABLE 19.—*Germany's exports and imports of barium chemicals.*

[From Vierteljahrshefte zur Statistik des Deutschen Reichs.]

	Exports.		Imports.	
	Short tons.	Value.	Short tons.	Value.
Blanc fixe, precipitated barium sulphate:				
1909	5,388	$98,853	15	$238
1910	6,003	111,954	20	476
1911	7,548	197,706	6	238
1912	9,147	222,955	7	238
1913	8,418	219,859	6	.....
Barium chloride:				
1909	5,865	126,722	2,012	43,114
1910	7,114	153,639	2,155	44,305
1911	6,812	154,830	2,217	45,496
1912	8,145	165,787	4,050	78,844
1913	6,227	135,059	2,863	58,835
Barium nitrate:				
1909	676	46,687	.....	.....
1910	1,088	72,889	.....	.....
1911	1,022	67,887	2	238
1912	893	62,885	3	238
1913	1,445	104,570	15	953

IMPORTS INTO THE UNITED STATES.

The imports of all barium chemicals (exclusive of lithopone and blanc fixe) in 1914 were 19,299,702 pounds, valued at $526,824.[1] Of this quantity about 66 per cent came from Germany. About 90 per cent of the importation in 1914 was represented by three barium salts, namely, precipitated barium carbonate, barium chloride, and barium dioxide. Table 20 shows the detail of the imports of barium chemicals in 1914 with countries of origin:

TABLE 20.—*Imports of barium chemicals by countries, fiscal year 1914.*[1]

Article.	Quantity.	Value.	Per cent of quantity, by countries.	
Barium:	*Pounds.*			
Carbonate (precipitated)	5,131,339	$47,648	Germany	80.6
			Belgium	11.9
			England	7.5
Chlorate—				
Commercial crystals	17,680	752	Switzerland	74.4
			England	25.6
Depurative	159	4	Germany	100.0
Chloride	6,118,387	65,443	....do	70.4
			Austria-Hungary	29.6
Dioxide (binoxide)	6,085,909	330,142	Germany	45.8
			England	42.0
			Belgium	12.2
Hydroxide—				
Commercial crystals	104,790	1,612	Germany	95.4
			England	4.0
			Belgium	.6
Chemically pure crystals	148	11	Germany	100.0
Pure exsiccated	2,555	401	....do	100.0
Hypophosphite	113	117	England	99.1
			Germany	.9
Nitrate—				
Crystals	1,040,772	38,728	....do	98.7
			Belgium	1.1
			England	.2
Powder, fused	2,200	411	Germany	100.0
Oxide—				
Hydrated, commercial crystals	3,047	96	....do	100.0
Hydrated, caustic, chemically pure exsiccated.	11	2	....do	100.0
Anhydrous chemically pure	4	2	....do	100.0
Peroxide—				
Anhydrous commercial powder	707,440	35,423	....do	50.4
			England	27.1
			Belgium	22.5
Pure hydrated	24	5	Germany	100.0
Sulphide—				
Crude lumps	12,373	930	....do	100.0
Purified	9,360	893	....do	100.0
Pure	622	148	....do	100.0
Sulphite	837	731	....do	100.0
Sulfocyanide	61,932	3,325	....do	97.0
			Canada	3.0
Total	19,299,702	526,824		

[1] Pickrell, Dr. E. R.: Chemicals and Allied Products Used in the United States, Department of Commerce, Miscellaneous Series No. 82.

Imports for consumption.—The imports of barium chemicals have practically ceased since 1915 owing to the severance of trade with Germany which was the chief source of supply. The imports of

practically all the barium chemicals prior to the war had increased to a maximum in 1914. The imports of barium chloride during the last six months of the 1919 calendar year (not shown in Table 21) were 1,096,396 pounds, valued at $19,063. This is the first barium chemical to be imported since the war in anything like the quantity of prewar imports. Table 21 shows the imports for consumption of the most important barium chemicals since 1910:

TABLE 21.—*Imports of barium chemicals for consumption in the United States.*

BARIUM CARBONATE, PRECIPITATED.

Fiscal year.	Rate of duty.	Quantity.	Value.	Duty collected.	Value per unit of quantity.	Actual and computed ad valorem rate.
		Pounds.				*Per cent.*
1912	25 per cent	946,971	$7,376	$1,844	$0.008	25.00
1913	do	2,182,517	20,143	5,035	.009	25.00
1914[1]	do	485,889	4,384	1,096	.009	25.00
1914[2]	15 per cent	4,509,562	42,041	6,306	.009	15.00
1915	do	344,588	7,864	1,179	.023	15.00
1916	do	6	2		.333	15.00
1917	do	804	177	26	.220	15.00
1918	do	106,288	1,437	215	.014	15.00
1919	do					

BARIUM CHLORIDE.

1910	25 per cent	3,705,502	$33,672	$8,418	$0.009	25.00
1911	do	2,742,486	29,771	7,442	.011	25.00
1912	do	2,834,980	27,766	6,941	.010	25.00
1913	do	2,926,159	26,341	6,585	.009	25.00
1914[1]	do	254,106	2,558	639	.010	25.00
1914[2]	¼ cent per pound	5,856,280	62,005	14,640	.011	23.61
1915	do	4,686,029	60,532	11,715	.013	19.35
1916	do	50	10		.200	1.30
1917	do	6,614	608	16	.092	2.72
1918	do					
1919	do	3,290	783	8	.238	1.05

BARIUM DIOXIDE OR BINOXIDE.

1910	25 per cent	3,563,528	$261,674	$65,418	$0.073	25.00
1911	do	4,896,563	347,129	86,782	.071	25.00
1912	do	3,715,823	255,053	63,763	.069	25.00
1913	do	3,507,508	215,500	53,875	.061	25.00
1914[1]	do	882,385	49,611	12,402	.056	25.00
1914[2]	1½ cents per pound	5,203,413	280,528	78,051	.054	27.82
1915	do	4,084,144	317,262	61,262	.077	19.31
1916	do	546,442	48,451	8,196	.088	16.92
(3)						

BLANC-FIXE OR ARTIFICIAL SULPHATE OF BARYTES, AND SATIN WHITE OR ARTIFICIAL SULPHATE OF LIME.

1910	½ cent per pound	5,656,507	$66,923	$28,282	$0.012	42.26
1911	do	6,332,699	73,278	31,663	.012	43.07
1912	do	5,702,262	70,925	28,511	.012	40.20
1913	do	4,808,726	58,499	24,043	.012	41.10
1914[1]	do	1,166,525	16,837	5,832	.014	34.72
1914[2]	20 per cent	3,585,949	43,804	8,760	.012	20.00
1915	do	2,233,369	25,748	5,149	.011	20.00
1916	do	492,723	11,523	2,304	.023	20.00
1917	do	408,163	10,029	2,005	.024	20.00
1918	do	179,200	2,376	475	.013	20.00
1919	do	1,285	90	18	.070	20.00

[1] From July 1 to Oct. 3, 1913.
[2] From Oct. 4, 1913 to June 30, 1914.
[3] No imports from 1917 to 1919, inclusive.

PRICES.

The price of barium chemicals increased more during the war than barytes, the raw material. This was undoubtedly due to the fact that this country did not possess a barium chemical industry and therefore the normal demand could not be met with the sudden cessation of imports from Germany. The price of barium chemicals increased rapidly to a high level in the latter part of 1916, which was three and four times the prewar prices. As the production of domestic manufacturers approached the demand, the prices declined somewhat (with the exception of barium chlorate). The prices existing during 1918 and 1919 were about twice the normal prewar prices. Prices of barium carbonate have not been quoted prior to 1919. During 1919 and the first half of 1920 the price was between $65 and $75 per ton. Table 26 shows the price by quarters of the various barium chemicals, as quoted in the Oil, Paint and Drug Reporter.

TABLE 22.—*Price of barium chemicals in the United States, spot, New York market.*

[From Oil, Paint and Drug Reporter.]

	Pulp blanc fixe, per ton.	Dry blanc fixe, per ton.	Barium salts.			
			Chlorate, per pound.	Nitrate, per pound.	Chloride, per ton.	Dioxide, per pound.
1912.			*Cents.*	*Cents.*		*Cents.*
January	$40.00–$43.00	$57.50–$80.00	15–17	5½– 6½	$31.50–$32.50	.....
April	40.00– 43.00	57.50– 80.00	15–17	5½– 6½	28.00– 30.00	.....
July	40.00– 43.00	57.50– 80.00	15–17	5½– 6½	28.00– 30.00	.....
October	40.00– 43.00	57.50– 80.00	15–17	5.1– 6	27.00– 28.00	.....
1913.						
January	40.00– 43.00	57.50– 80.00	15–17	5¾– 6	32.00– 32.50	.....
April	40.00– 43.00	57.50– 80.00	15–17	5¾– 6	33.00 33.50	.....
July	40.00– 43.00	57.50– 80.00	15–17	5¾– 6	31.50– 32.50	.....
October	40.00– 43.00	57.50– 80.00	13–13½	5¾– 6	32.00– 32.50	.....
1914.						
January	40.00– 43.00	57.50– 80.00	13–13½	5¾– 6	32.50– 33.00	.....
April	40.00– 43.00	57.50– 80.00	13–13½	5¾– 6	32.00– 32.50	.....
July	40.00 43.00	77.50– 80.00	13–13½	5¾– 6	32.00– 32.50	.....
October	40.00– 43.00	77.50– 80.00	16–16½	14 –16	120.00–130.00	.....
1915.						
January	40.00 43.00	77.50– 80.00	16–16½	12 –14	50.00– 60.00	.....
April	40.00– 43.00	77.50– 80.00	16–16½	12 –14	60.00	.....
July	45.00	60.00– 65.00	16–16½	12 –14	70.00– 80.00	22
October	45.00	60.00– 65.00	16–16½	15 –16	95.00–100.00	22
1916.						
January	45.00	80.00	16–16½	15 –16	110.00	22
April	70 00	80.00	50–60	15 –16	..... 140.00	22
July	120.00	120.00–140.00	50–60	15 –16	110.00–120.00	38
October	120.00	90.00	50–60	15 –16	100.00–110.00	38
1917.						
January	80.00– 85.00	110.00	50–60	15 –16	97.50–102.50	38
April	35.00– 40.00	80.00– 85.00	50–60	13 –14	92.50–100.00	38
July	35.00– 40.00	80.00– 85.00	50–60	12 –13	90.00– 95.00	38
October	35.00– 40.00	80.00– 85.00	50–60	12 –13	80.00– 90.00	38

TABLE 22.—*Price of barium chemicals in the United States, spot, New York market*—Continued.

	Pulp blanc fixe, per ton.	Dry blanc fixe, per ton.	Barium salts.			
			Chlorate, per pound.	Nitrate, per pound.	Chloride, per ton.	Dioxide, per pound.
1918.			*Cents.*	*Cents.*		*Cents.*
January	$35.00–40.00	$75.00–80.00	50–60	11–14	$65.00–90.00	20–25
April	35.00–60.00	95.00–105.00	Nominal.	12–14	65.00–85.00	Nominal.
July	35.00–60.00	110.00–120.00	50–60	12–14	[1]65.00–70.00	25–30
October	35.00–60.00	110.00–120.00	50–60	12–14	[1]65.00–70.00	25–30
1919.						
January	35.00–60.00	110.00–120.00	50–60	11½–12	[2]85.00–87.00	25–27
April	35.00–50.00	70.00–90.00	50–60	10–11	82.00–85.00	25–27
July	35.00–50.00	70.00–90.00	50–60	10–11	70.00–80.00	25–27
October	35.00–50.00	70.00–90.00	50–60	10–11	80.00–85.00	25–27
1920.						
January	35.00–50.00	80.00–100.00	59–60	10–11	90.00–95.00	21½–22
April	40.00–50.00	100.00	50–60	17–18	150.00–175.00	23 ..
July	40.00–50.00	120.00	50–60	17–18	175.00–180.00	22½–25

[1] 80 per cent grade. [2] Listed during 1919–20 as barium chloride, white crystals.

TARIFF HISTORY.

Prior to the tariff act of 1913 the only barium chemical mentioned by name was blanc fixe or artificial sulphate of barium, which was first mentioned in the act of 1890 as dutiable at three-fourths cent per pound. The other barium chemicals were dutiable prior to the passage of the act of 1913 as chemical compounds and salts n. s. p. f. The act of 1913 mentions three barium salts by name in addition to mentioning blanc fixe, and alloys of metallic barium. The tariff classification of the finished barium products since the passage of the act of 1883 is as follows:

Act of—	Paragraph.	Tariff classification or description.	Rates of duty, specific and ad valorem.
1883.....	92	* * * and all chemical compounds and salts, * * * not specially enumerated or provided for in this act.	25 per cent ad valorem.
1890.....	51	Blanc-fixe, * * * or artificial sulphate of barytes....	¾ cent per pound.
	76	* * * and all chemical compounds and salts, not specially provided for in this act.	25 per cent ad valorem.
1894.....	39	Blanc-fixe, or artificial sulphate of barytes.....	25 per cent ad valorem.
	60	* * * and all chemical compounds and salts, not specially provided for in this act.	25 per cent ad valorem.
1897.....	46	Blanc-fixe, or artificial sulphate of barytes * * *	¼ cent per pound.
	3	* * * and all chemical compounds and salts not specially provided for in this act.	25 per cent ad valorem.
1909.....	3	* * * chemical compounds, mixtures and salts * * * not specially provided for in this section.	25 per cent ad valorem, or 55 cents per lb. if more.
	44	Blanc-fixe, or artificial sulphate of barytes * * *	¼ cent per pound.
1913.....	5	* * * and all chemical * * * compounds * * *, mixtures and salts * * * .	15 per cent ad valorem.
	10	Barium,	
		Chloride of.....	¼ cent per pound.
		Dioxide of.....	1½ cents per pound.
		Carbonate of, precipitated.....	15 per cent ad valorem.
	51	* * * blanc-fixe, or artificial sulphate of barytes * * * .	20 per cent ad valorem.
	143	* * * barium, * * * and alloys of which said metals are the component material of chief value.	25 per cent ad valorem.

PART IV

THE LITHOPONE INDUSTRY

PART IV.

THE LITHOPONE INDUSTRY.

DESCRIPTION AND USES.

Lithopone (incorrectly spelled lithophone) is a white pigment which consists of a mixture of approximately 70 per cent barium sulphate and 30 per cent of zinc calculated as zinc sulphide. The zinc is present in lithopone as 26 to 28 per cent of zinc sulphide and 1 to 3 per cent of zinc oxide, according to conditions of manufacture. The lithopone produced in this country by all manufacturers is a standard product of approximately the composition given above, which is about in proportion to the chemical equivalents of barium sulphate and zinc sulphide. In Europe lithopone is commonly sold in grades containing more or less zinc sulphide than the standard of 30 per cent. For example, the following grades of lithopone are sold on the German market: Gelbsiegel (yellow seal), 11 to 18 per cent zinc sulphide; Blausiegel (blue seal), 22 to 30 per cent zinc sulphide; Grünsiegel (green seal), 32 to 42 per cent zinc sulphide.

Lithopone is known commercially under various brand names in addition to the general name of lithopone. The trade names used by various manufacturers, with the exception of the Sherwin-Williams Co., of Cleveland, Ohio, which firm markets their product simply as lithopone, are as follows:

Beckton White, E. I. du Pont de Nemours & Co., Wilmington, Del.
Ponolith, Krebs Pigment & Chemical Corporation, Newport, Del.
Marbon White, Mineral Refining & Chemical Corporation, St. Louis, Mo.
Zincolith, Chemical Pigments Corporation, Philadelphia, Pa.
Sterling White, Midland Chemical Co., Chicago, Ill.
B–J White, Butterworth-Judson Corporation, New York.
Grasselli White, Grasselli Chemical Co., Cleveland, Ohio.
Green Label and Standard, New Jersey Zinc Co., New York.
Colzo Lithopone, Collinsville Zinc Corporation, St. Louis, Mo.

Lithopone is used extensively as a white pigment in flat and enamel wall paints for interior use. The chief competitors of lithopone as a pigment are white lead, zinc oxide, and leaded zinc oxide. It is also used in large quantities as an inert filler in rubber goods, paper, linoleum, oilcloth, and in window-shade cloth. As a rule lithopone is not extensively used in outside paints because of the property of darkening when exposed to sunlight. In recent years there have been placed on the market brands of lithopone which are said to withstand exposure to sunlight.

DOMESTIC PRODUCTION.

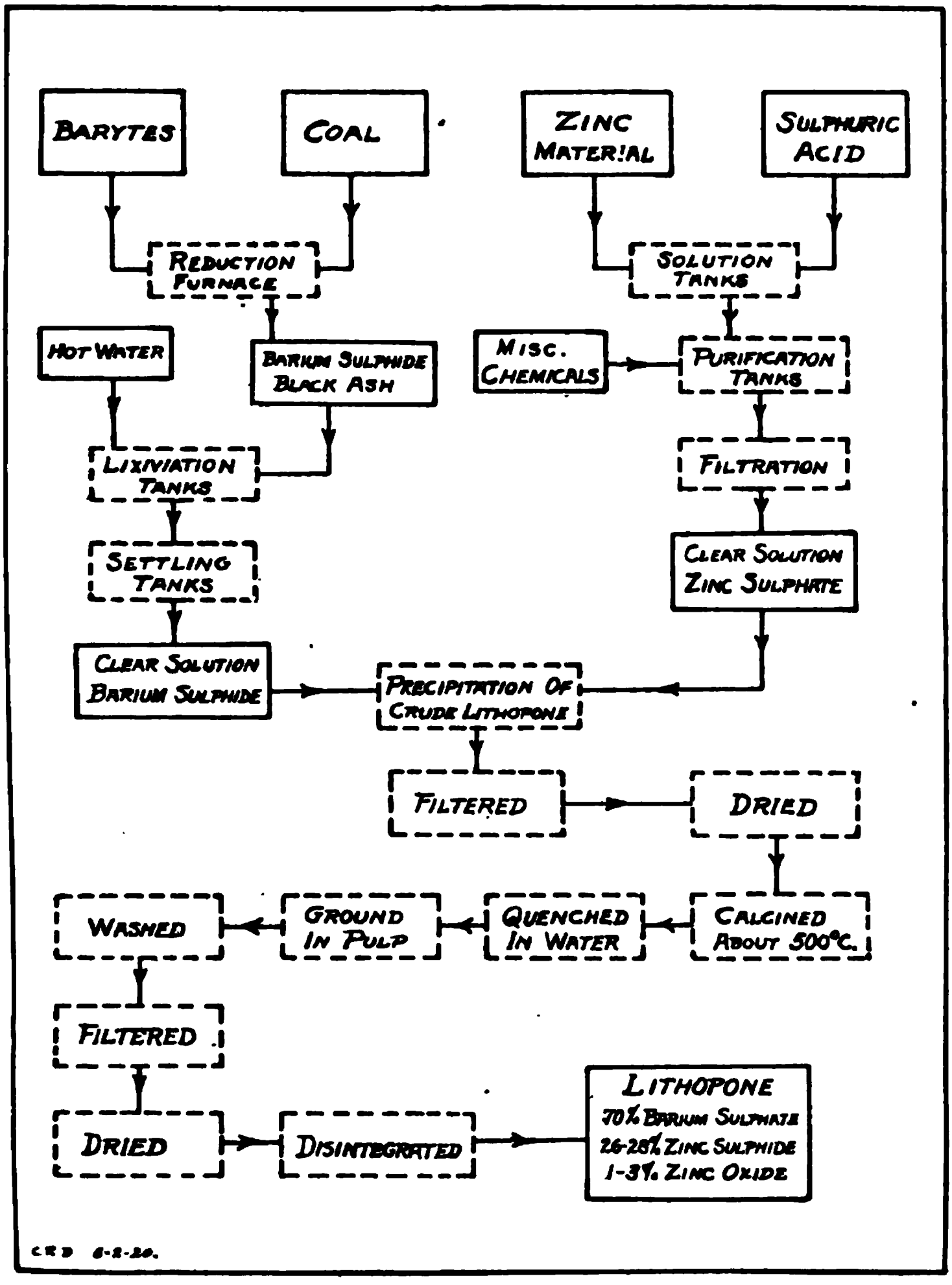
Raw materials.—The basic raw materials necessary for the manufacture of lithopone are crude barytes, coal or coke, zinc, and sulphuric acid. Other chemicals are required in the process of manufacture, but in minor quantities. Large quantities of clear, soft water are required in making up the solutions of materials and in the washing of the lithopone to remove soluble impurities. Of these materials, this report is especially concerned with crude barytes. The other basic raw materials are available from domestic sources, and, with the exception of zinc, present no special tariff problem.

The barytes requirements of lithopone manufacturers prior to the war were supplied wholly by imports, chiefly from Germany. The entire lithopone industry was then located along the Atlantic coast, at or within a short distance of tidewater. Under these conditions crude barytes could be imported at a cost of about $5.20 per short ton, delivered at plant, which was less than the price at which domestic barytes could be purchased. The stoppage of imports of crude barytes from Germany as a result of war conditions forced the lithopone manufacturers to seek a domestic supply. This condition and the establishment of a barium chemical industry was responsible for the domestic development of crude barytes production in the southern district, as previously described. (See p. 21.) It is reasonably certain, with restoration of normal competitive conditions and under existing tariff duties (15 per cent ad valorem) on crude barytes, that lithopone manufacturers located along the Atlantic coast will return to imports as the source of their barytes requirements. Regardless of a duty, the lithopone manufacturers located in the Middle West will use chiefly crude barytes from the Missouri district. The relation of the cost of crude barytes to the total cost of manufacturing lithopone is shown on page 87. From this it is possible to calculate the effect of an increase or decrease in the cost of crude barytes on the cost of lithopone, other factors remaining fixed.

Process of manufacture.—The manufacture of lithopone requires the preliminary production of a solution of barium sulphide and a solution of zinc sulphate. The preparation of barium sulphide by roasting barytes with coal has already been described. (See p. 44.) The zinc sulphate solution is prepared by dissolving some form of zinc (zinc ash, scrap, skimmings, spelter, or roasted ore) in dilute sulphuric acid. Since the zinc materials used contain, as a rule, other metals as impurities (chiefly iron, copper, or cadmium), which would form colored products on treatment with barium sulphide, it is necessary to purify thoroughly the zinc sulphate solution. Various chemicals are used at this point for purification of the zinc

FIGURE 4.—DIAGRAM OF THE MANUFACTURE OF LITHOPONE

Solid lines——Raw, intermediate, or finished products
Broken lines- - - -Apparatus, or steps in process



sulphate solution, which is one of the most important steps in the manufacture and requires careful chemical control.

Crude lithopone is now precipitated from the purified zinc sulphate solution as a white insoluble substance by adding a hot solution of barium sulphide. The crude lithopone is filtered from the solution, then dried, and calcined in a muffle furnace at about 500° C., which may or may not utilize waste heat from the roasting of the barytes with coal. The hot product from the furnace is thrown into water ("quenching"), ground in pulp, washed several times with water to remove soluble impurities, filtered, and dried. The dry lithopone is run through a disintegrator, which breaks it up into a fine powder, and it is then packed in bags or barrels for shipment. In some cases the lithopone is air floated to insure a uniformly fine product before packing. The process of manufacturing lithopone is shown graphically in Figure 4.

Production and consumption.—The production of lithopone in the United States has shown a rapid growth during the last 10 years. From 1910 to 1919 the production increased nearly sixfold, or from 25,330,000 pounds to about 145,000,000 pounds. During this period the domestic output of lithopone has supplied from 84 to 100 per cent of the total consumption. There has been relatively little competition from imported lithopone. The growth of the lithopone industry can be attributed to the increased utilization of this commodity and the natural growth of the consuming industries during the last 10 years. Although exports of lithopone are not shown separately in Commerce and Navigation, it is known that a fairly large export trade has developed in lithopone during 1920.

Table 23 shows the figures for the production, importation, and consumption of lithopone in this country from 1910 to 1919, inclusive. Figure 5 shows graphically the relation of imports and production of lithopone to the total consumption in the United States.

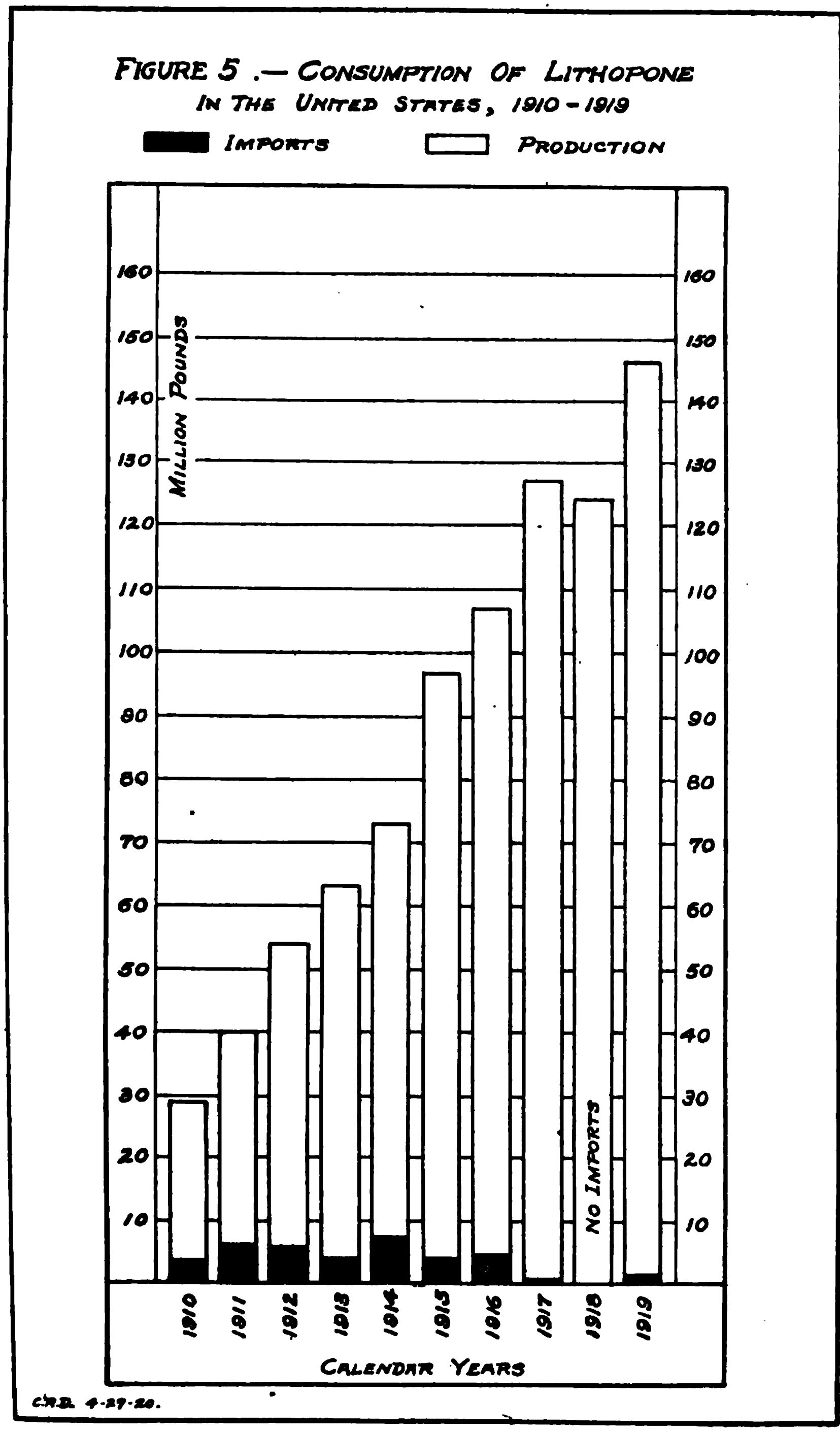
TABLE 23.—*Production and consumption of lithopone in the United States.*

Calendar year.	Production.[1]			Imports.[2]		Consumption.
	Quantity.	Value.	Per cent of consumption (quantity).	Quantity.	Value.	
	Pounds.			*Pounds.*		*Pounds.*
1910	25,330,000	$916,512	87.1	3,726,135	$99,954	29,056,135
1911	33,732,000	1,243,108	84.1	6,355,312	166,199	40,087,312
1912	48,440,000	1,702,119	89.1	5,904,475	153,303	54,344,475
1913	59,370,000	2,170,445	93.6	4,054,423	122,063	63,424,423
1914	65,638,000	2,490,530	89.7	7,544,148	259,955	73,182,148
1915	92,988,000	3,760,472	95.8	4,087,826	137,816	97,075,826
1916	102,582,000	5,798,927	95.6	4,681,560	405,730	107,263,560
1917	127,426,000	7,394,531	99.6	448,000	29,199	127,874,000
1918	124,806,000	7,923,209	100.0	.....	.....	124,806,000
1919	145,000,000	.....	99.0	1,477,296	122,708	146,477,296

[1] 1910 to 1918, inclusive, from Mineral Resources, U. S. Geological Survey. 1919 from reports submitted to the Tariff Commission by individual manufacturers.

[2] From 1910 to Oct. 3, 1913, listed as "white sulphide of zinc."

FIGURE 5 .— CONSUMPTION OF LITHOPONE IN THE UNITED STATES, 1910-1919



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Geographical distribution.—The domestic lithopone industry, prior to the war, was confined to the Atlantic coast district. Most of the plants were located at tidewater and were thus favorably situated as regards the supply of the raw material, barytes, imported from Germany. According to the Geological Survey there were in 1914 three manufacturers in New Jersey, two in Pennsylvania, and one in Delaware. The Geological Survey reported production of lithopone during 1915 at Chicago by the Midland Chemical Co. This marked the beginning of the lithopone industry in the Middle West and the utilization of local barytes in the manufacture of this paint pigment. There has since been considerable development of the lithopone industry in the Middle West. At the present time there are two manufacturers located in the Chicago district and two in the St. Louis territory. On the basis of the 1919 production about 80 per cent of the lithopone is produced in the Atlantic coast district.

The manufacturers of lithopone, their office addresses, and location of plants are as follows:

E. I. du Pont de Nemours & Co., Wilmington, Del. (Plants at Philadelphia, Pa., Camden and Newark, N. J.)

Krebs Pigment & Chemical Co., Newport, Del. (Plant same address.)

Chemical Pigments Corporation, 617 Stock Exchange Building, Philadelphia, Pa. (Plant at St. Helena, Baltimore, Md.)[1]

Midland Chemical Co., 208 South La Salle Street, Chicago, Ill. (Plant at Argo, Ill.)

New Jersey Zinc Co., 160 Front Street, New York. (Plant at Palmerton, Pa.)

Grasselli Chemical Co., Cleveland, Ohio. (Plant at Grasselli, N. J.)

Sherwin-Williams Co., Cleveland, Ohio. (Plant at Kensington, Ill.)

Butterworth-Judson Corporation, 61 Broadway, New York. (Plant at Newark, N. J.)

Mineral Refining & Chemical Corporation, St. Louis, Mo. (Plant at St. Louis, Mo.)

Collinsville Zinc Corporation, St. Louis, Mo. (Plant at Collinsville, Ill.)

FOREIGN PRODUCTION.

Little information is available as to the size of the lithopone industry in foreign countries. It is known that the principal producers are Germany and Belgium. Table 24 shows Germany's exports and imports of lithopone prior to the war.

TABLE 24.—*Germany's exports and imports of lithopone, 1909–1913.*

[From Vierteljahrshefte zur Statistik des Deutschen Reichs.]

Year.	Exports.		Imports.	
	Quantity.	Value.	Quantity.	Value.
	Short tons.		*Short tons.*	
1909	8,337	$450,436	2,736	$141,967
1910	11,639	503,078	3,684	159,118
1911	15,148	730,559	3,003	129,819
1912	16,825	793,206	3,676	174,839
1913	19,326	950,180	3,405	176,506

[1] Purchased in June, 1920, by the Glidden Co., Cleveland, Ohio.

IMPORTS INTO THE UNITED STATES.

From 1911 to 1916, inclusive, the imports of lithopone were fairly constant at 5,000,000 to 6,000,000 pounds annually with the exception of 1914 when the imports were a little over 8,000,000 pounds. The average dutiable value of lithopone during this period was from 2.5 to 3.1 cents a pound except in 1916 when the price increased to 8.1 cents a pound. In 1917 the imports decreased sharply and during 1918 and 1919 remained between 230,000 and 450,000 pounds a year. Imports of lithopone have supplied only a small portion of the domestic consumption of lithopone. Table 25 shows the imports for consumption of lithopone from 1910 to 1919, inclusive.

TABLE 25.—*Imports of lithopone for consumption in the United States 1910–1919.*[1]

Fiscal year.	Rate of duty.	Quantity.	Value.	Duty collected.	Value per unit of quantity.	Actual and computed ad valorem rate.
		Pounds.				*Per cent.*
1910	1¼ cents per pound	2,307,699	$68,925	$28,846	$0.029	41.85
1911	do	5,409,520	145,201	67,619	.027	46.57
1912	do	6,325,072	157,921	79,063	.025	50.07
1913	do	5,163,642	144,812	64,545	.028	44.57
1914 [2]	do	847,563	25,777	10,594	.030	41.10
1914 [3]	15 per cent	7,245,151	218,133	32,719	.030	15.00
1915	do	6,185,245	195,828	29,374	.031	15.00
1916	do	5,122,083	414,573	62,185	.081	15.00
1917	do	231,869	20,591	3,088	.089	15.00
1918	do	448,000	29,199	4,379	.065	15.00
1919	do	233,338	17,678	2,652	.076	15.00

[1] From 1910 to Oct. 3, 1913, listed as "white sulphide of zinc."
[2] July 1 to Oct. 3, 1913, under act of 1909.
[3] Oct. 4, 1913, to June 30, 1914, under act of 1913.

PRICES.

Domestic.—The price of lithopone from 1912 to 1915 was constant at about 3¾ cents a pound. The price increased to a maximum of 14½ cents a pound in the second and third quarters of 1916. During 1917, 1918, and 1919 the price ranged from 6 to 8 cents a pound, an average of about double the prewar price. The price on July 3, 1920, was 7¾ cents a pound in bags and 8–8¼ cents a pound in barrels, car lots. Table 26 shows the general trend of the price of lithopone as quoted by the Oil, Paint and Drug Reporter.

TABLE 26.—*Prices of lithopone, spot quotation, New York market.*

[Cents per pound.]

First of month.	1912	1913	1914	1915	1916	1917	1918	1919
January	3½–4	3½–4½	3½–4½	3½–4½	6½–7	6½–6½	6½–7	7½–8¼
April	3½–4	3½–4½	3½–4½	4½–4¾	14½–15½	6½–6½	7 –8½	[1] 6½
July	3½–4	3½–4½	3½–4½	6	14½–15½	6½–6½	7½–8½	6½
October	3½–4½	3½–4½	3½–4½	5½–6½	8½–10	6 –6½	8 –8½	7

[1] Listed from here on as lithopone, in barrels, car lots.

Foreign.—The following prices fixed by the Association of German Lithopone Manufacturers for export countries were received by the Commission from a reliable source. The prices apply for the last half of 1919.

TABLE 27.—*Prices of 30 per cent lithopone (per 100 kilos) fixed by German manufacturers for export.*[1]

France, Belgium, Luxemburg, and the Levante	francs	108
Switzerland and Italy	Swiss francs	75
Spain and Portugal	pesetas	70
Holland	florins	37
Scandinavia	kroner	62
America	dollars	13
England, South America, Japan, and other oversea countries not otherwise specified	pounds sterling	[2]33

The price to the United States of $13 per 100 kilograms is equivalent to 5.72 cents a pound f. o. b. Rotterdam with the discount deducted. The price prevailing in the United States during the last half of 1919 was 6½ to 7 cents a pound.

TARIFF HISTORY.

The term "lithopone" did not appear in the tariff law until the act of 1913, when, in paragraph 61, "lithopone and white sulphide of zinc" were provided for with a duty of 15 per cent ad valorem. Under the act of 1890 lithopone was dutiable as "white paint containing zinc, but not containing lead; dry" at 1¼ cents per pound (Gabriel *v.* United States, 65 Fed., 422; G. A. 1319, T. D. 12670), and under the act of 1897 as "sulfid of zinc white, or white sulphide of zinc," at 1¼ cents a pound (Gabriel *v.* United States, 123 Fed., 296). This duty during the fiscal years 1910 to 1913, inclusive, was equivalent to from 42 to 50 per cent ad valorem.

[1] All these prices are subject to 3 per cent discount or rebate for 25 ton orders and upward and are packed in free casks of 250 kilos net with a negligible extra for smaller packages. Delivered Rotterdam or frontier stations.

[2] Per English ton.

PART V

COSTS OF PRODUCTION IN THE BARYTES, BARIUM CHEMICAL, AND LITHOPONE INDUSTRIES, 1919

PART V.

COSTS OF PRODUCTION IN THE BARYTES, BARIUM CHEMICAL, AND LITHOPONE INDUSTRIES, 1919.

Summary of Costs.

Representatives of the Tariff Commission held conferences in New York, Washington, and St. Louis with producers and manufacturers, who agreed to submit their costs of production to the Commission on their own cost forms. These cost reports, after tabulation and study, were verified by comparison with the books of the companies by members of the Commission's staff.

The averages of costs as shown in the tables presented are in all cases weighted averages, based on the actual production of the companies reporting. In no case has a simple average been used in presenting costs. For example, the average cost of lithopone for 1919 has been obtained by dividing the sum of the total cost of all companies by the aggregate production of all companies. This method obviously gives more weight in the average to the costs of a company with a large production than to the costs of a company with a small production. It is believed that the weighted average costs, as given, are representative of conditions in the industries as a whole.

The cost of mining crude barytes in western mines increased from $5.30 per short ton in 1916 to $7.74 in 1919, while the increase in southern mines was from $3.89 to $7.39 per short ton. This corresponds to an increase of 90 per cent for southern mines and 46 per cent for western mines. The cost of manufacturing ground barytes was $11.21 per short ton in 1914; $12.69 in 1916; and $19.25 in 1919, an increase of about 70 per cent from 1914 to 1919. The cost of producing barium chemicals during 1919 was $0.0294 per pound for blanc fixe; $0.0316 per pound for barium carbonate; $0.0539 per pound for barium chloride, and $0.197 per pound for barium peroxide. The average cost of manufacturing lithopone during 1919, as reported by 11 plants, was $0.0602 per pound. Of this total cost 43 per cent was due to material; 18 per cent to labor; 34 per cent to overhead; and 5 per cent to sales expense. The apparent profit of the industry was $0.0065 per pound of lithopone produced. The rela-

tion of crude barytes to the lithopone industry is shown by the fact that about 14 per cent of the total factory cost of lithopone was due to barytes. Zinc is the most expensive material entering into lithopone and amounted to about 22 per cent of the total factory cost. The average factory cost was $0.0571 per pound of lithopone.

Cost of Mining Barytes, 1916 and 1919.

INTRODUCTORY.

The costs of mining barytes during 1916 and 1919, as presented in the following pages, are separated for western and southern mines because of the different methods of mining used. (See p. 24.) In western mines the methods of keeping costs are as a rule inadequate, except in the case of the larger firms. The information submitted by smaller operators has been accepted, although in some cases accurate records were not available for purposes of complete verification. In such instances, however, the costs submitted agreed closely with those of larger operators, whose costs were checked to their books, and therefore they have been included in the following tables. The cost records of southern mines were found to be in better condition than those of western mines. A large part of the mining in the southern district is done by large consumers of crude barytes, who keep accurate records. There was, however, very little uniformity in the detail of costs submitted by the various companies.

The outstanding difference in costs as reported by companies in both mining districts was in the charge for amortization of investment due to depletion of ore body and in royalties paid owners of the property for mining privileges. In many cases no charge was reported. As it would be manifestly unfair to include a charge for amortization in one case and not in another, a total cost based on a uniform charge for amortization and royalties for all companies has been shown in the tables of costs of mining barytes. It has seemed feasible to use uniformly the weighted average of the charges reported. In a few cases where charges reported as amortization appeared excessive on account of being based on a short period, they were not used in arriving at the uniform charge.

The costs as given for barytes in all cases are the costs on board cars for shipment. This seemed a more desirable basis for comparison between districts, because this cost plus freight rates gives the cost of crude barytes delivered at any point in the United States. The costs, therefore, as given include hauling, weighing, and loading in the case of the western mines and switching or hauling charges in the case of the southern mines.

COMPARISON OF COSTS IN WESTERN AND SOUTHERN MINES.

TABLE 28.—*Comparison of total cost of mining barytes in western and southern mines during 1916 and 1919.*

[Per short ton.]

1	2	3	4	5
Year.	Cost in western mines.		Cost in southern mines.	
	As reported.	On uniform amortization and royalty basis.	As reported.	On uniform amortization and royalty basis.
1916	$5.30	$5.96	$3.89	$3.89
1919	7.74	7.97	7.39	6.31

Table 28, which compares the costs in the western and southern mines, shows that the cost of production during 1916 and 1919 was lower in the southern than in the western mines. In 1916 the difference in the costs "as reported" (columns 2 and 4) was $1.41 per short ton. On a basis of uniform amortization and royalties (columns 3 and 5) the difference was even greater and amounted to $2.07 per short ton. This is due to the fact that in only a few cases did western mines report a charge for amortization or royalties. In 1919 the difference in costs between the two districts was considerably less. The costs "as reported" in 1919 showed a difference of $0.35 per short ton, and on the basis of "uniform amortization and royalties" a difference of $1.66 per short ton in favor of the southern mines.

Table 28 also shows that the increase in the cost of producing barytes from 1916 to 1919 "as reported" was much greater in case of the southern mines than the western mines. The total average cost in southern mines increased from $3.89 per short ton in 1916 to $7.39 in 1919, or an increase of 90 per cent. The average cost in the western mines increased from $5.30 per ton in 1916 to $7.74 per ton in 1919, or an increase of about 46 per cent. On a basis of "uniform amortization and royalties" the costs in western mines increased about 33 per cent and in southern mines by about 62 per cent during this period.

A study of costs in western and southern mines reveals a considerable difference in labor charge per ton of barytes. This is to be expected from the methods used in the two districts. The western deposits are worked by pick and shovel and require more labor, while the southern deposits are mined by steam shovels. In 1916 the cost of labor in western mines was $2.37 per ton as compared with $1.62 per ton for southern mines, or a difference of $0.75 per ton.

In 1919 the charge for labor in western mines was $4.38 as against $2.82 in southern mines, or a difference of $1.56 per ton. The labor per ton of ore in western mines increased about 85 per cent from 1916 to 1919, while in southern mines there was an increase of 74 per cent. The difference in labor per ton of ore mined in favor of southern mines is in part offset by larger overhead charges, due to necessary investment in mining equipment.

COSTS IN WESTERN MINES.

The methods of mining and conditions in the western fields are unique. Practically all of the mining is done by individuals on a tonnage basis. Each miner is paid a certain rate per ton of ore mined. Other charges are on the same basis. The prices paid for ore delivered at the loading platform at the shipping point are fairly uniform. The price paid for hauling to the shipping point varies with the distance. The miner receives the difference. In other words, the net price received per ton of ore by miners located close to the railroad is greater than that received by miners some distance from the railroad. This condition results in most of the mining being done close to the railroad. A large part of the mining is on property owned by consumers of crude barytes. These companies permit miners to work the property, and they usually furnish the miners with housing free of charge as an inducement to keep them on the property.

TABLE 29.—*Cost of mining barytes in western mines during 1916, by companies.*

[Per short ton.]

1	2	3	4	5	6	7	8
	Total cost.		Detail of total cost as reported (column 2).				
Company No.	As reported.	On uniform amortization and royalty basis.	Labor in mining.	Transportation to shipping point.	Weighing and loading.	Amortization and royalties.	Other expenses.
1	$6.17	$6.25	$2.36	$1.98	$0.35	$0.97	$0.51
2	6.30	6.10	3.00	1.50	.25	1.25	.30
3	6.75	7.80	1.50	4.00	.25	.....	1.00
4	3.80	4.85	2.70	.80	.19	.....	.11
Weighted average cost	5.30	5.96	2.37	1.87	.25	{ .39 [1] 1.05 }	.42

[1] Uniform charge for amortization and royalties used in arriving at total cost in column 3.

Table 29 shows the cost of mining barytes by western mines during 1916 by companies. The total weighted average cost "as reported" of $5.30 per ton is made up of the following charges: $2.37

for labor in mining, or 45 per cent; $1.87 for transportation to shipping point, or 35 per cent, and $0.25 for weighing and loading, or 4.7 per cent. Amortization and royalties were reported by only two firms and are the only charges for these items included in the total average cost of $5.30. By applying a uniform charge for amortization and royalties ($1.05), which was the weighted average of the two charges reported, the average costs for each firm, as shown in column 3, were obtained. This method increases the average cost as reported by $0.69 per ton, or 13 per cent.

TABLE 30.—*Cost of mining barytes in western mines during 1919, by companies.*

[Per short ton.]

1	2	3	4	5	6	7	8
Company No.	Total cost.		Detail of total cost as reported (column 2).				
	As reported.	On uniform amortization and royalty basis.	Labor in mining.	Transportation to shipping point.	Weighing and loading.	Amortization and royalties.	Other expenses.
1	$7.66	$7.47	$4.56	$2.01	$0.13	$0.96	.....
2	9.45	10.22	2.50	5.35	.30	.....	$1.30
3	7.00	7.77	5.88	1.00	.12	.....	.....
4	8.50	8.77	2.00	6.00	.....	.50	.....
5	8.03	7.09	3.20	2.48	.17	1.71	.47
6	8.82	9.59	5.60	1.40	.80	.....	1.02
7	7.80	8.57	6.00	1.40	.30	.....	.10
8	8.00	7.27	4.50	1.50	.25	1.50	.25
9	8.10	8.87	5.00	1.60	.30	.....	1.20
10	7.59	7.76	3.77	2.01	.17	.60	1.04
Weighted average cost....	7.74	7.97	4.38	2.01	.20	{ .54 / [1] .77 }	.61

[1] Uniform charge for amortization and royalties used in arriving at total cost, column 3.

Table 30, identical with Table 29, except that the costs given are for the year 1919, shows a total weighted average cost for 1919 "as reported" by 10 companies of $7.74 per short ton. By applying a uniform charge for amortization and royalties the total average cost was increased to $7.97 per short ton, or by about 3 per cent. The total average cost "as reported" is made up of the following charges: Labor in mining of $4.38 per short ton, or 56.5 per cent; transportation to shipping point of $2.01 per short ton, or 26 per cent; weighing and loading of $0.20 per ton, or 2.6 per cent; amortization and royalties of $0.54 per ton, or 7 per cent; and other expenses of $0.61 per ton, or 7.9 per cent. The total cost as shown in column 3 is based on a uniform charge for amortization and royalties, which was $0.77 per short ton, or the weighted average of all firms reporting a charge for amortization and royalties as shown in column 7.

This method increased the cost as reported by all companies, with the exception of three firms.

The charge for "labor in mining," as shown in column 4, is the charge which was reported by the various companies, with the exception of companies 1 and 10. These two firms reported labor in mining and transportation to shipping point combined. The weighted average charge as reported by all other companies for transportation to shipping point has been applied to costs of these two firms, in order to arrive at a figure for labor in mining. As shown by column 4, the labor in mining varied between companies from $2 per ton to $6 per ton. This variance in cost of labor is offset by the charge for transportation as shown in column 5. The transportation charge varied from $1 per ton to $6 per ton. Wherever a high charge for labor is reported a low transportation charge is usually given. The cost delivered at shipping points, or the sum of columns 4 and 5, is fairly uniform, because of existing conditions which have previously been discussed. (See p. 66.) The transportation costs as given are those reported by the various companies, with the exception of companies 1 and 10, as noted above.

Column 6 shows the charge for weighing and loading the crude barytes on board cars, which was reported by all firms but one—company 4. This charge shows a variation from $0.12 per ton to $0.80 per ton. Column 7 shows the amortization and royalties as reported by 5 of the 10 companies. This charge ranged from $0.50 per ton to $1.71 per ton. The weighted average for the five companies reporting was $0.77 per ton, and was used in arriving at the total cost in column 3. The average charge of $0.54 per ton is the total of charges for amortization and royalties divided by the total production of all firms, and was used in arriving at the total cost "as reported" shown in column 2. Column 8 shows other expenses charged to cost of mining barytes. Under this heading are included such overhead items as administration, housing furnished miners, and losses in weight during shipping.

COSTS IN SOUTHERN MINES.

The costs of mining barytes, as shown for southern mines, include companies operating in the Sweetwater, Tenn., and Cartersville, Ga., districts. Only three firms were able to report costs for 1916, because the industry was developed in this district as a result of war conditions, and at this stage of the development little attention was given to cost records. The costs of the companies reporting, however, may be taken as representative for the year 1916. In 1919 the industry in these districts was more fully developed and costs were reported by 12 companies.

TABLE 31.—*Costs of mining barytes in southern mines during 1916, by companies.*

[Per short ton.]

1	2	3	4	5	6
Company No.	Total cost (as reported).	Labor in mining.	Supplies in mining.	Amortization and royalties.	Other expenses.
1	$4.00	$1.25	$0.10	$0.50	$2.15
2	3.71	1.29	.25	1.51	.66
3	4.08	2.29	.....	.25	1.54
Weighted average cost	3.89	1.62	.14	.90	1.23

Table 31 shows the cost of mining barytes by southern mines during 1916. The total weighted average cost "as reported" was $3.89 per short ton, and is made up of $1.62 for labor in mining, or 41.7 per cent; $0.14 for supplies in mining, or 3.6 per cent; $0.90 for amortization and royalties, or 23.1 per cent; and $1.23 for other expenses, or 31.6 per cent. A charge for supplies in mining (column 4) was reported by only two of the three firms, and was $0.10 per ton in one case and $0.25 per ton in the other. Since an amortization and royalty charge was shown by all firms and the charge appeared reasonable, it was not necessary to apply a uniform amortization and royalty charge to the costs.

TABLE 32.—*Costs of mining barytes in southern mines during 1919, by companies.*

[Per short ton.]

1	2	3	4	5	6	7
	Total cost.		Detail of Total Cost as reported (Column 2).			
Company No.	As reported.	On uniform amortization and royalty basis.	Labor in mining.	Supplies in mining.	Amortization and royalties	Other expenses.
1	$6.85	$6.48	$2.50	$0.15	$1.00	$3.20
2	12.25	12.21	5.88	2.67	.67	3.03
3	10.92	11.10	6.06	2.37	.45	2.05
4	10.93	4.92	2.53	.97	6.64	.79
5	5.16	5.06	4.02	.....	.73	.41
6	6.58	6.32	3.34	.50	.89	1.85
7	5.80	5.05	2.14	.03	1.38	2.25
8	5.24	5.87	1.06	.....	.....	4.18
9	8.64	9.27	3.62	.42	.....	4.60
10	9.77	9.54	6.63	.47	.86	1.81
11	7.06	7.44	3.90	.....	.25	2.91
12	6.82	7.45	3.03	1.13	.....	2.66
Weighted average cost	7.39	6.31	2.82	.46	{ 1.71 [1] 0.63 }	2.40

[1] Uniform charge for amortization and royalties used in arriving at the total cost in column 3.

Table 32 shows the cost of mining barytes in southern mines during 1919, as reported by 12 companies. The total weighted average cost, "as reported" (column 2), was $7.39 per short ton, and is made up of the following charges: $2.82 for labor in mining, or 38.2 per cent; $0.46 for supplies in mining, 6.2 per cent; $1.71 for amortization and royalties, or 23.2 per cent; and $2.40 for other expenses, or 32.4 per cent. Column 3 shows the total cost of mining barytes on the basis of a uniform amortization and royalty charge. The total weighted average cost on this basis is $6.31 per short ton, or a decrease of $1.08 per ton, or 14.6 per cent from the total average cost, "as reported." The uniform charge used in arriving at this total cost was $0.63 per ton. This charge was arrived at by taking the weighted average of the amortization and royalty charges shown in column 6, with the exception of certain charges which were omitted. Column 7 shows other expenses charged by the various companies to cost of mining barytes during 1919, which include charges for administration, power, and other overhead expenses.

Cost of Manufacturing Ground Barytes, 1914, 1916, and 1919.

INTRODUCTORY.

The cost of manufacturing ground barytes, as shown, includes companies operating plants both in the southern and western districts. It was impossible to compare costs between the two districts on account of the small number of manufacturers. In compiling the costs on ground barytes the Commission found that the various companies kept detailed cost records. There was very little uniformity, however, in the detail of the costs, as reported.

It should be pointed out that the company numbers used in presenting costs of ground barytes do not necessarily represent the same company for all years. For example, costs given as those of company 1 during 1914, 1916, and 1919 are not directly comparable as those of the same firm.

COMPARISON OF COSTS FOR 1914, 1916, AND 1919.

TABLE 33.—*Comparison of costs of manufacturing ground barytes during 1914, 1916, and 1919.*

[Per short ton.]

1	2	3	4	5	6	7	8	9	10
Year.	Total cost.	Factory cost.						Selling expenses.	
		Total.	Material.		Labor.		Overhead.		
			Cost.	Per cent of total cost.	Cost.	Per cent of total cost.	Cost.	Per cent of total cost.	Cost.	Per cent of total cost.
1914	$11.21	$10.61	$6.13	54.7	$1.30	11.6	$3.18	28.4	$0.60	5.3
1916	12.69	11.98	8.08	63.7	1.08	8.5	2.82	22.2	.71	5.6
1919	19.25	18.63	10.68	55.5	2.47	12.8	5.48	28.5	.62	3.2

Table 33 compares the total average cost of manufacturing ground barytes during 1914, 1916, and 1919, and the percentage of the total cost due to the various items of cost. Column 2 shows that the total cost increased from $11.21 in 1914 to $19.25 in 1919. The total cost, as given in column 2, is the sum of the total factory cost in column 3 and selling expense in column 7. Column 3 shows that the total

factory cost increased from $10.61 in 1914 to $18.63 in 1919. This increase is in practically the same ratio as the total cost, since the selling expense during the different years was practically uniform at between $0.60 and $0.71 per ton, as shown in column 7. Column 4 shows that the material charge varied from $6.13 in 1914 to $10.68 in 1919. The charge for material is the principal cost item entering into the total cost of ground barytes and amounted to between 55 and 65 per cent of the total factory cost. Column 5 shows the labor charges per ton of ground barytes, which decreased from $1.30 per ton in 1914 to $1.08 in 1916 and then increased to $2.47 per ton in 1919. Labor accounted for 8.5 to 13 per cent of the total cost. Column 6 shows that the overhead expense decreased from $3.18 in 1914 to $2.82 in 1916 and then increased to $5.48 in 1919. Overhead expense was 22 to 29 per cent of the total cost. Selling expense was between 3 and 5.5 per cent of the total cost.

DETAIL OF COSTS OF GROUND BARYTES, BY COMPANIES.

TABLE 34.—*Cost of manufacturing ground barytes, by companies, during 1914.*

[Per short ton.]

1	2	3	4	5	6	7
Company No.	Total cost.	Factory cost.				Selling expenses.
		Total.	Material.	Labor.	Overhead.	
1	$12.09	$11.57	$5.65	$1.88	$4.04	$0.52
2	10.51	9.88	6.43	.74	2.72	.63
3	12.49	11.89	6.16	2.13	3.60	.60
4	11.74	11.14	5.72	2.08	3.34	.60
Weighted average cost	11.21	10.61	6.13	1.30	3.18	.60

Table 34 shows the cost of manufacturing ground barytes by companies during 1914. Column 2 shows that the total weighted average cost as reported by four companies during 1914 was $11.21 per short ton. The total average cost was made up of the following charges: $6.13 per ton for material, or 54.7 per cent; $1.30 per ton for labor, or 11.6 per cent; $3.18 per ton overhead charges, or 28.4 per cent; and $0.60 per ton for selling expenses, or 5.3 per cent.

The total factory cost shown in column 3 is made up of the items material, labor, and overhead. The average factory cost of the four companies reporting was $10.61 per ton. Companies 1 and 2 were the only firms that reported selling expense (column 7). The weighted average of these two firms was taken as the average selling expense and substituted for companies 3 and 4 in arriving at the total cost in column 2 for these two firms.

TABLE 35.—*Cost of manufacturing ground barytes, by companies, during 1916.*

[Per short ton.]

1	2	3	4	5	6	7
Company No.	Total cost.	Factory cost.				Selling expenses.
		Total.	Material.	Labor.	Overhead.	
1	$15.69	$14.99	$9.63	$1.11	$4.25	$0.70
2	11.49	10.77	8.00	.54	2.23	.72
3	12.43	11.72	6.28	2.05	3.39	.71
4	13.24	12.53	7.58	2.07	2.88	.71
Weighted average cost	12.69	11.98	8.08	1.08	2.82	.71

Table 35 shows the cost of manufacturing ground barytes by companies during 1916. Column 2 shows that the average cost of the four companies was $12.69. The average cost is made up of a charge of $8.08 for material, or 63.7 per cent; $1.08 for labor, or 8.5 per cent; $2.82 for overhead, or 22.2 per cent; and $0.71 for selling expenses, or 5.6 per cent. Column 3 shows that the total average factory cost was $11.98. The selling expenses as reported by companies 1 and 2 was $0.70 and $0.72 per ton, respectively. The weighted average of these two charges, or $0.71, was inserted as the selling expenses for companies 3 and 4, and was used in arriving at the total cost shown in column 2 for these two companies.

TABLE 36.—*Cost of manufacturing ground barytes, by companies, during 1919.*

[Per short ton.]

1	2	3	4	5	6	7
Company No.	Total cost.	Factory cost.				Selling expenses.
		Total.	Material.	Labor.	Overhead.	
1	$25.61	$24.73	$12.50	$3.00	$9.23	$0.88
2	19.07	18.10	11.59	1.26	5.25	.97
3	14.51	13.89	7.40	3.26	3.23	.62
4	19.54	19.35	10.74	3.08	5.53	.19
Weighted average cost	19.25	18.63	10.68	2.47	5.48	.62

Table 36 shows the cost of ground barytes during 1919 as reported by four companies. The total weighted average cost (column 2) was $19.25 per ton. This total cost was made up of the following charges: $10.68 per ton for material, or 55.5 per cent; $2.47 for labor, or 12.8 per cent; $5.48 for overhead, or 28.5 per cent, and $0.62 for selling expenses, or 3.2 per cent. The total factory cost, as shown in column 3, averaged $18.63 per ton. During 1919 all companies reported

separately a charge for selling expenses, with the exception of No. 3, which firm included selling under overhead. The weighted average of the three firms separately reporting a charge was inserted for company 3, and subtracted from that company's overhead as reported and from total cost shown in column 2 to obtain the total factory cost. The average selling expense of the three companies reporting was $0.62 per short ton.

TABLE 37.—*Details of overhead charged to ground barytes, 1919.*

[Per short ton.]

1	2	3	4	5
Company No.	Total overhead.	Works expense.	Fixed charges.	Administration.
1	$9.23	$7.45	$0.58	$1.20
2	5.25	2.29	2.54	.42
3	3.23	2.92	.....	.31
4	5.53	5.07	.....	.46
Weighted average	5.48	4.03	.....	.50

The detail in which overhead charges for ground barytes were reported varied greatly. Therefore the total overhead is the only fair basis of comparison between companies. The overhead during 1919 as reported by the four companies manufacturing ground barytes is given in Table 37 in as much detail as was possible. Although not directly comparable by companies, the table shows the detail to which overhead was distributed. The total overhead as shown in column 2 varied between companies from $3.23 to $9.23 per short ton of ground barytes produced.

Column 3 shows the total of the items charged to works expense, which includes such items of cost as operating and miscellaneous supplies, repairs, coal or electric power, packages, and other general plant expense. Works expense is seen to be the largest overhead charge, and averaged $4.03 per short ton, or about 70 per cent of the total overhead. Column 4 shows fixed charges as reported by only two companies. This heading includes insurance, State and local taxes, and depreciation. Only one firm reported a charge for depreciation. Column 5 shows administration expense as reported by all companies. This heading includes salaries for factory superintendence and office expense and salaries. Administration expense averaged $0.50 per short ton, or about 10 per cent of the total overhead.

Costs of Manufacturing Barium Chemicals, 1919.

INTRODUCTORY.

Before discussing the costs of barium chemicals the Commission desires to point out the lack of adequate cost-finding methods found to be prevalent in the barium chemical industry. The Commission does not wish to convey the impression that all companies manufacturing barium chemicals do not keep accurate cost records, but a number of the firms engaged in this industry lack adequate methods of cost accounting, and the data obtained from the records of these companies are at best an approximation of the true cost. This condition may be accounted for by the fact that the industry was developed under stress of war conditions, with emphasis on output rather than on economy of operation and on accurate cost records. Now that the industry is approaching more stabilized conditions, more attention should be given to cost accounting by those firms which now have inadequate methods. The Commission emphasizes the fact that some of the manufacturers of barium chemicals have adequate cost systems, and had this condition uniformly prevailed the cost investigation would have been greatly facilitated. From the information available the Commission is able to present the following costs of barium chemicals, and believes that the costs given may be taken as representative of the industry.

COMPARISON OF COSTS OF BARIUM CHEMICALS.

TABLE 38.—*Cost of manufacturing barium chemicals during 1919.*

[Per pound.]

Name of product.	Manufacturers reporting.	Total cost.	Material.		Labor.		Overhead and selling expense.	
			Cost.	Per cent of total.	Cost.	Per cent of total.	Cost.	Per cent of total.
Barium carbonate	3	$0.0316	$0.0167	52.9	$0.0038	12.0	$0.0111	35.1
Barium peroxide	3	.197	.088	44.7	.046	23.3	.063	32.0
Blanc fixe [1]	3	.0294	.0160	54.4	.0028	9.5	.0106	36.1
Barium chloride	4	.0539	.0218	40.5	.0109	20.2	.0212	39.3

[1] Precipitated barium sulphate.

Table 38 shows the weighted average costs of four barium chemicals—barium carbonate, barium peroxide, barium chloride, and blanc fixe or precipitated barium sulphate. This table also shows the

total cost distributed to the three items—material, labor, and overhead. The Commission is unable to publish costs submitted on other barium chemicals without disclosing the costs of the one or two firms reporting. The barium chemicals for which costs are given are, however, the most important, and include all barium chemicals mentioned by name in the tariff act of 1913. The costs of these may be taken as representing conditions in the industry.

It has been necessary, because of the form in which costs were kept by the companies, to combine overhead and selling expenses. In all cases selling expense is included, with the exception of one firm manufacturing barium chloride. Depreciation on plant and equipment is included in overhead where reported. A charge for depreciation was reported by all manufacturers of barium peroxide; by three of the four manufacturers of barium chloride; and by one manufacturer of barium carbonate. No depreciation was reported by manufacturers of blanc fixe. Other discrepancies in cost items are discussed under the variation in costs by companies.

Table 38 shows that the total average cost for precipitated barium carbonate, as reported by three manufacturers, was $0.0316 per pound. This cost was made up of the following items: Material charge of $0.0167, or 52.9 per cent; labor charge of $0.0038, or 12 per cent; and overhead and selling expenses of $0.0111, or 35.1 per cent. This table shows a total average cost for barium peroxide of $0.197 per pound as reported by three companies. Of this total, $0.088, or 44.7 per cent, was due to material charges; $0.046, or 23.3 per cent to labor charge; and $0.063, or 32 per cent, to overhead and selling expenses. The total average cost of blanc fixe for three firms is shown as $0.0294 per pound. This total cost is made up of $0.0160 material charge, or 54.4 per cent; $0.0028 labor charge, or 9.5 per cent; and $0.0106 overhead and selling expenses, or 36.1 per cent. The total average cost of barium chloride for 1919 as reported by four manufacturers was $0.0539 per pound. This total was made up of material charge of $0.0218, or 40.5 per cent; labor charge of $0.0109, or 20.2 per cent; and overhead and selling expenses of $0.0212, or 39.3 per cent.

The barium chemicals in order of their cheapness of manufacture, as shown in Table 38, are blanc fixe, barium carbonate, barium chloride, and barium peroxide. This order would be expected from a knowledge of the process of manufacture. Blanc fixe and barium carbonate, whose costs vary by only 0.22 cent per pound, are made from comparatively cheap chemicals, are precipitated as insoluble compounds, and require but simple operations, such as filtration and drying before marketing. Barium chloride, although made from a cheap material—calcium chloride—is a soluble compound and requires considerable heat for evaporation of solutions. This

is reflected in a higher overhead charge than for blanc fixe and barium carbonate. Barium peroxide requires a higher degree of manufacture than any of the other barium chemicals. It is made from intermediate barium chemicals—barium carbonate or barium nitrate. Large quantities of heat are required for its manufacture, which is reflected in the largest unit overhead charge. Based on percentage of total cost, however, the overhead for barium peroxide is less than for blanc fixe or barium carbonate.

From a study of Table 38 it is seen that the cost of materials is in inverse ratio to the total cost of production. The percentage of the total cost due to material ranges from 40.5 per cent in the case of barium chloride to 54.4 per cent in the case of blanc fixe. It is also seen that the cost due to labor is in direct ratio to the total cost of the various barium chemicals. The percentage of the total cost due to labor ranges from 9.5 per cent for blanc fixe to 23.3 per cent for barium peroxide. The percentage of the total cost due to overhead and selling expense is more nearly uniform than the other cost charges. This charge ranges from 32 per cent of the total cost for barium peroxide to 39.3 per cent of the total cost for barium chloride.

VARIATIONS IN COSTS OF BARIUM CHEMICALS, BY COMPANIES.

TABLE 39.—*Percentage variation in costs of barium chemicals, by companies, for 1919.*

	Total cost.	Material.	Labor.	Overhead and selling expense.
Barium carbonate:				
Company No. 1	101	170	66	58
Company No. 2	100	100	100	100
Company No. 3	69	108	30	52
Barium peroxide:				
Company No. 1	135	246	49	61
Company No. 2	100	100	100	100
Company No. 3	92	63	174	78
Blanc fixe (precipitated barium sulphate):				
Company No. 1	181	178	178	185
Company No. 2	96	139	91	37
Company No. 3	100	100	100	100
Barium chloride:				
Company No. 1	100	100	100	100
Company No. 2	86	136	54	61
Company No. 3	151	255	73	104
Company No. 4	164	91	189	212

Table 39 shows by percentage the variation in the total cost and in the items of cost of each barium chemical by manufacturers. Because of the few manufacturers of each chemical it was impossible to show the variation in costs by publishing the actual units. In each case the firm with the median total cost has been taken as the unit of 100. The other costs are calculated as a percentage of this unit. As can be seen from Table 39 it is generally true that a manufacturer

who has the lowest total cost is not always low in all departments of cost.

This table shows a variation in the total cost of barium carbonate from 69 to 101, or a difference of nearly 50 per cent of the low cost. This difference may be due to differences in process of manufacture. methods of treating by-products, or to individual plant and process efficiencies. There are two general methods used in the manufacture of barium carbonate. The one is to treat barium sulphide with soda ash, thus obtaining by-product sodium sulphide. The other method is to convert the barium sulphide into barium carbonate by means of carbon dioxide. This method does not give a by-product. The accounting method used in treating sodium sulphide may vary between manufacturers with a resulting reflection in the total cost. Sodium sulphide was uniformly treated as a joint product, and the raw-material charges divided between barium carbonate and sodium sulphide on an arbitrary basis. The basis of distribution of raw material, however, varied between the manufacturers. The method followed by each firm has been used in arriving at the total cost.

The total cost of barium peroxide ranged from a low of 92 to a high of 135, or a difference of nearly 50 per cent of the low cost. The variation in the cost of barium peroxide may be accounted for largely by the difference in process of manufacture. It is produced by two methods, one using barium carbonate as the raw material and the other using barium nitrate. The difference in total cost is reflected chiefly in the material charge which shows a difference between the low and high of about 300 per cent. The company with the highest total cost had the lowest labor, while the firm with the lowest total cost had the highest labor cost.

The total cost of blanc fixe varied from 96 to 181, as shown in Table 39. This is a difference of nearly 100 per cent of the low cost. In arriving at the total cost for blanc fixe in the case of one firm it was necessary for comparison to substitute an average material charge, which was the weighted average of the material charges reported by the other two manufacturers. From a study of the variation of costs of blanc fixe, it is seen that the company with the highest total cost is the highest in all departments of cost. This is the only case where one company is the highest in all cost items. What has been said of the effect of sodium sulphide on the cost of barium carbonate, also applies to costs of blanc fixe. Some of the companies reporting blanc fixe costs obtain sodium sulphide as a by-product, while others produce blanc fixe by a process which does not yield sodium sulphide. These differences are necessarily reflected in total costs.

The total cost of barium chloride reported by four companies ranged from a low of 86 to a high of 164, or a difference of about 90 per cent of the low cost. Three of the firms use similar processes involving the direct production of barium chloride from barytes by reduction with coal in the presence of calcium chloride. The other firm reporting made barium chloride from an intermediate barium chemical. The difference in total cost, however, can not be accounted for wholly by differences in process of manufacture. It is interesting to note that the firm with the highest total cost had the lowest material cost, but had high labor and overhead and selling charges.

Cost of Manufacturing Lithopone, 1919.

INTRODUCTORY.

The Commission's investigation of costs in the lithopone industry was greatly facilitated by the fact that practically all companies kept detailed cost records. The methods of accounting used by the lithopone manufacturers were more detailed and in a more comparable form than those of the barytes and barium chemical industries. This may be accounted for by the fact that the lithopone industry is much larger, has been longer established, and is on a more permanent basis than the other industries. Although costs were shown in detail, there was considerable lack of uniformity in methods of treating individual cost items. The outstanding differences were methods of handling raw material charges, methods of determining selling expenses, and treatment of administrative expenses. These differences are discussed fully in the following pages.

In analyzing the cost statements on lithopone for 1919, and in comparing and presenting the cost data of the industry, the methods used by the majority of the companies in distributing the charges have been followed as closely as possible. Wherever changes have been necessary in order to facilitate comparison, they are explained in the discussion of the individual cost items. Where companies operate more than one plant and have reported separate costs for each, they have been tabulated as if for separate companies. The costs for lithopone as shown represent 11 plants, operated by 9 companies. Two plants did not report costs for the first quarter of the year 1919, and one plant presented costs for the last quarter only. The costs of these plants have been used as representative of the entire year.

COMPARISON OF COSTS OF LITHOPONE BY QUARTERS.

TABLE 40.—*Weighted average cost of lithopone during 1919 by quarters.*

[Per pound.]

1	2	3	4	5	6	7	8	9
Quarterly periods.	Production.	Total cost.	Material cost.	Direct labor cost.	Factory overhead.	Selling expense.	Average sales price.	Apparent average profit.
	Pounds.							
First	24,613,042	$0.0639	$0.0264	$0.0101	$0.0239	$0.0035	$0.0709	$0.0070
Second	28,479,697	.0573	.0254	.0103	.0191	.0025	.0633	.0060
Third	41,222,083	.0574	.0254	.0112	.0182	.0026	.0640	.0066
Fourth	48,204,354	.0623	.0264	.0111	.0213	.0035	.0664	.0041
Year	142,519,176	.0602	.0259	.0108	.0204	.0031	.0667	.0065

Table 40 shows the weighted average cost of lithopone for all plants by quarters during 1919. The total average cost for all companies reporting, as shown, is the sum of the items—material, direct labor, factory overhead, and selling expense. This table also shows in column 9 the average profit for the industry by comparing the average gross selling price with the total weighted average cost.

Column 2 shows the production of lithopone by the companies reporting costs during 1919, by quarters. These figures of production were used in obtaining the weighted average costs for each quarter and for the entire year 1919. The figures, however, do not necessarily represent total production of lithopone, because of the omission of certain companies who did not report costs for the whole year. These figures show inactivity in the lithopone industry during the first half of 1919. The production as shown during the first six months was only 53,000,000 pounds, as against 89,500,000 during the last six months of 1919.

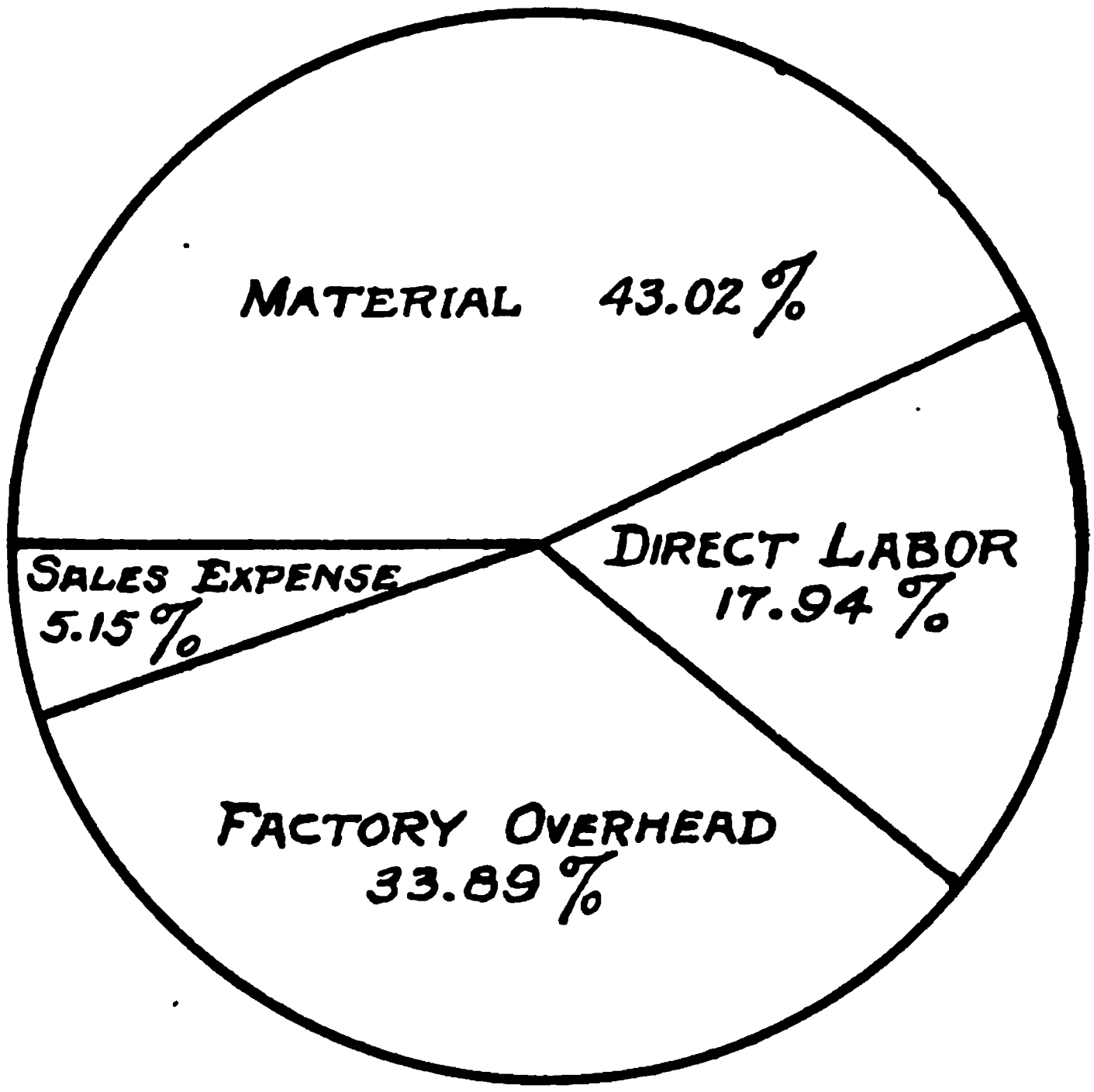
Column 3 shows that the total weighted average cost of lithopone for all companies during 1919 was $0.0602 per pound. This average cost was made up of $0.0259 per pound, or 43 per cent for material; $0.0108 per pound, or 17.9 per cent for direct labor; $0.0204 per pound, or 33.9 per cent for overhead; and $0.0031 per pound, or 5.2 per cent for sales expense. The distribution of the total cost of lithopone according to items of expense for the year 1919 is shown diagrammatically in Figure 6. Column 3 also shows that the highest cost for lithopone was $0.0639 per pound during the first quarter of the year. The cost during the second and third quarters was uniform at $0.0573 per pound and increased in the fourth quarter to $0.0623 per pound.

The material cost, as shown in column 4, is the actual unit cost of raw materials used in the manufacture of lithopone, as shown by the books of the various companies. The items making up material cost, as recorded by the various manufacturers, differed greatly. Some companies reported the basic raw materials—barytes, coal for reduction of barytes, zinc, and sulphuric acid. Other companies reported the intermediate materials—barium sulphide and zinc sulphate—which are made from the basic raw materials given above. The relation between the basic raw materials and the intermediate materials, barium sulphide and zinc sulphate, is shown in the diagram of the manufacture of lithopone, Figure 4, page 55. In other words, by this latter method the companies carry separate cost accounts for the intermediate products, barium sulphide and zinc sulphate, and then charge these products at the actual cost of manufacture against their lithopone account as raw materials. Where this latter method has

been followed we have attempted to segregate the cost of zinc sulphate and barium sulphide into labor, raw material, and overhead. This estimated segregation has been done by determining the percentages of labor, raw material, and overhead by a study of the sepa-

FIGURE 6 —DISTRIBUTION OF LITHOPONE COST - 1919

[AVERAGE COST = $0.0602 A POUND]



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rate cost sheets for zinc sulphate and barium sulphide and then applying these percentages in distributing the charges for the zinc sulphate and barium sulphide, as reported under lithopone cost, to raw material, labor, and overhead. The amounts due to labor and over-

head have been deducted from the lithopone material charge and added to labor and overhead reported under lithopone cost. This method of distribution may result in slight discrepancies between individual cost items, but in no case has the total material charge, as reported by any company, been changed unless an offsetting change has been made in some other department of cost, so that the total cost for any company has not been changed because of this arbitrary method of allocation. Column 4 shows that the average material cost for all companies during the year 1919 was $0.0259 per pound of lithopone, or 43 per cent of the total average cost. This column also shows that the material costs followed the general trend of the total cost during the year, although there was only a difference of 0.1 cent per pound between the material cost by quarters. The highest material charge was $0.0264 during the first and fourth quarters, while the material charge for the second and third quarters was uniform at $0.0254 per pound.

The direct labor cost, as shown by column 5, is derived from the figures reported by the companies plus any labor charge resulting from the arbitrary allocation due to differences in reporting raw materials, as discussed above under column 4. Column 5 shows that the average direct labor charge for all companies during 1919 was $0.0108 per pound, or 17.9 per cent of the total cost. The direct labor charge was fairly uniform during the year, and ranged from $0.0101 in the first quarter to $0.0112 in the third quarter.

The factory overhead cost shown in column 6 is made up of the five general charges—works expense, bags and barrels, fixed charges, laboratory expense, and administrative expense. These units have been derived from the report as submitted by the respective manufacturers, with the exception of those companies which reported interest on capital invested in inventory, building, machinery, and equipment, as a charge against lithopone costs. Where these items were given, they have been excluded in arriving at the total average cost of production. This has been necessary for purposes of comparison, because these charges were not reported by all companies, and in many cases where reported they were not actual book charges. There have also been a few minor changes in overhead expense, as reported by companies, which was necessary because of the arbitrary allocation of material charges, as previously explained under column 4 of this table. Column 6 shows that the average factory overhead for all companies during 1919 was $0.0204 per pound of lithopone, or 33.9 per cent of the total average cost. This charge ranged during the year from $0.0182 in the third quarter to $0.0239 during the first quarter.

Column 7 shows the total selling expense charged by the various manufacturers to their lithopone account. Selling expense as reported showed considerable variation in regard to both the method of determination and the relative amounts which were charged. Several of the firms manufacturing lithopone have large sales organizations which also handle other products. Some of these companies distribute the expense of the whole sales organization to the various products according to the value of the sales of the individual products. Those companies making only lithopone usually charged the actual cost of sales. Two other methods were found to be used in determining sales expense. One is to charge a certain percentage of the selling price as sales expense; one firm using this method combines sales and administrative expense. The other is to charge a fixed sum per unit of lithopone produced as sales expense. In all cases, however, the amounts as reported by individual companies have been included in the total average cost of lithopone. Column 7 shows that the average selling expense during 1919 was $0.0031 per pound of lithopone, or 5.2 per cent of the total cost. The selling cost ranged from $0.0025 in the second quarter to $0.0035 in the first and fourth quarters.

In determining the average price received by all companies, as shown in column 8, the gross price received by each company has been used. This unit has been multiplied by the total production of each company and the aggregate for all companies divided by the total production of all companies. By this method the weighted average gross sales price has been obtained. In the case of the few companies not reporting gross sales price, these companies have been omitted in arriving at the weighted average for each quarter and the year. Column 8 shows that the average gross sales price during 1919 was $0.0667 per pound of lithopone. In column 9 is shown the apparent average gross profit, obtained by subtracting the average total cost (column 3) from the average gross sales price (column 8). This estimated average profit during 1919 was $0.0065 per pound of lithopone. The profit shown during the year varied considerably—from $0.0041 in the fourth quarter to $0.0070 per pound in the first quarter.

VARIATION IN COSTS OF LITHOPONE, BY COMPANIES.

TABLE 41.—*Average cost per pound of lithopone during 1919, by companies.*

[Per pound.]

1	2	3	4	5	6	7	8
Plant No.	Total cost.	Material cost.	Direct labor cost.	Factory overhead.	Selling expense.	Average sales price.	Average profit or loss (—).
1	$0.0529	$0.0248	$0.0058	$0.0203	$0.0020	$0.0649	$0.0120
2	.0536	.0258	.0105	.0151	.0022	.0631	.0095
3	.0574	.0221	.0124	.0218	.0011	.0636	.0062
4	.0586	.0230	.0154	.0166	.0036	.0649	.0063
5	.0609	.0232	.0083	.0228	.0066	.0660	.0051
6	.0635	.0283	.0090	.0208	.0054	.0687	.0052
7	.0643	.0288	.0135	.0201	.0019	.0627	—.0016
8	.0653	.0307	.0211	.0121	.0014	.0696	.0043
9	.0697	.0251	.0111	.0324	.0011	.....	.....
10	.0744	.0303	.0095	.0276	.0070	.0714	.0030
11	.0751	.0329	.0085	.0274	.0063	.....	.....
Weighted average	.0602	.0259	.0108	.0204	.0031	.....	.....

Table 41 shows the cost of manufacturing lithopone by companies during the year 1919. This table also shows the average sales price received by each company and the average profit or loss of each firm with the exception of two companies for whom no sales price was reported.

Column 2 shows that the total cost of the 11 plants ranged from a low cost of $0.0529 per pound of lithopone to a high cost of $0.0751 per pound, a variation of about 40 per cent of the low cost. A study of this column shows that there were only four plants with a cost lower than the total weighted average of $0.0602 per pound. Based on production, however, about 60 per cent of the lithopone produced during 1919 was manufactured at a cost less than the average cost. The variation in costs between manufacturers is not in accordance with quantity production as might be expected. There are large producers represented in column 2 with high costs, and there are small producers with low costs.

Column 3 shows the material cost per pound of lithopone as reported by various manufacturers. This column shows a variation in material cost ranging from $0.0221 to $0.0329 per pound. The plant with highest material cost has the highest total cost, but the plant with the lowest material cost is not low in total cost. Six firms report a material cost below the average of $0.0259 per pound.

Column 4 shows the direct labor cost per pound of lithopone. This charge ranged from $0.0083 to $0.0211 per pound, a difference of 150 per cent of the low cost. Six plants show a direct labor cost below the average cost of $0.0108 per pound. The difference in labor

cost between the various manufacturers may be accounted for largely by design and equipment of plant. Although not all lithopone plants were visited by representatives of the Commission, those visited, which appeared to be well designed and utilized labor-saving devices wherever possible, uniformly show a low labor cost per pound of lithopone. There appears to be opportunity for plants with a high labor cost to lower their total cost of lithopone by a greater use of labor-saving devices and better design of plant.

Column 5 shows that the factory overhead per pound of lithopone ranged from a low cost of $0.0121 to a high cost of $0.0324. This is a difference of $0.0203 per pound, or about 165 per cent of the low cost. Five plants show a factory overhead charge lower than the average of $0.0204 per pound.

Column 6 shows the selling expense per pound of lithopone as reported by the different manufacturers. This charge ranged from $0.0011 to $0.0066 per pound of lithopone or a variation of 500 per cent of the low cost. This variation in selling expense is greater than for any other item of cost shown. Six plants show a selling expense lower than the average of $0.0031.

Column 7 shows the average net sales price received by each plant, with two exceptions. The average net price received for all sales during 1919 ranged from $0.0631 per pound to $0.$714 per pound, a variation of $0.0083 per pound. The sales price as shown in column 7 is not a quoted price on lithopone, but is the actual average net price received by each firm for sales during 1919; freight, discounts, and commissions have been deducted.

Column 8 shows the average profit or loss by companies represented by subtracting the total cost (column 2) from the average sales price obtained (column 7). As previously stated, interest on capital investment was not included in arriving at the total cost, and therefore this factor has had no influence on the average profit or loss shown in column 8. This column shows that one plant lost $0.0016 per pound of lithopone, while the other plants made a profit ranging from $0.0030 to $0.0120 per pound.

DETAILS OF MATERIAL COSTS.

TABLE 42.—*Details of material cost compared by percentages with total factory cost of lithopone during 1919, by companies.*

[Costs are per pound. Per cent is of total factory cost.]

1	2	3	4	5	6	7	8	9	10	11	12
Company No.	Total factory cost.	Total material.		Barytes.		Zinc.		Sulphuric acid.		All other materials.	
		Cost.	Per cent.	Cost.	Per cent.	Cost.	Per cent.	Cost.	Per cent.	Cost.	Per cent.
1	$0.0509	$0.0248	48.72	$0.0086	16.89	$0.0127	24.96	$0.0025	4.91	$0.0010	1.96
2	.0514	.0258	50.20	.0091	17.70	.0112	21.79	.0027	5.26	.0028	5.45
3	.0563	.0221	39.26	.0067	11.90	.0100	17.76	.0030	5.33	.0024	4.27
4	.0550	.0230	41.82	.0078	14.18	.0122	22.18	.0023	4.18	.0007	1.28
5	.0543	.0232	42.72	.0053	9.76	.0122	22.47	.0028	5.15	.0029	5.34
6	.0581	.0283	48.71	.0085	14.63	.0128	22.03	.0027	4.65	.0043	7.40
7	.0624	.0288	46.15	.0068	10.89	.0141	22.60	.0040	6.41	.0039	6.25
8	.0639	.0307	48.04	.0083	12.99	.0149	23.32	.0034	5.32	.0041	6.41
9	.0686	.0251	36.59	.0072	10.49	.0139	20.26	.0018	2.62	.0022	3.22
10	.0674	.0303	44.96	.0075	11.13	.0153	22.70	.0041	6.09	.0034	5.04
11	.0688	.0329	47.82	.0096	13.95	.0153	22.24	.0034	4.94	.0016	6.69
WEIGHTED AVERAGE OF ALL COMPANIES.											
First quarter, 1919	.0604	.0264	43.71	.0082	13.57	.0125	20.70	.0032	5.30	.0025	4.14
Second quarter, 1919	.0548	.0254	46.35	.0077	14.05	.0122	22.26	.0026	4.75	.0029	5.29
Third quarter, 1919	.0548	.0254	46.35	.0081	14.78	.0124	22.63	.0026	4.75	.0023	4.19
Fourth quarter, 1919	.0588	.0264	44.90	.0076	12.93	.0127	21.60	.0030	5.10	.0031	5.27
Year	.0571	.0259	45.37	.0079	13.84	.0124	21.72	.0029	5.08	.0027	4.73

Table 42 shows by companies the detail of material cost compared with total factory cost. This table also shows the weighted average material charge for all companies during each quarter and for the entire year of 1919. The total factory cost as shown in column 2 does not include sales expense and is the sum of material, direct labor, and factory overhead charges. The average factory cost for all companies during the entire year was $0.0571 per pound of lithopone produced. This is a weighted average of individual factory costs ranging from $0.0509 to $0.0688 per pound.

Column 3 shows that the total average material cost for the entire year was $0.0259 per pound, or 45.37 per cent of the total factory cost as shown by column 4. The cost of barytes, column 5, for all companies during 1919 averaged $0.0079 per pound of lithopone, or 13.84 per cent of the total factory cost, column 6. The percentage of the factory cost of lithopone due to crude barytes is important in considering a duty on crude barytes and its effects on the cost of lithopone. The average cost of the crude barytes as reported by 9 of the 11 plants was $13.60 per short ton. With this information the effect of an increase or decrease in the cost of crude barytes on the cost of lithopone can be calculated. For example, a 10 per cent increase or decrease in the cost of barytes given above ($13.60) will

cause an increase or decrease of 1.384 per cent of the total factory cost of lithopone.

An average of 8 of the 11 plants for which costs were reported shows that 1.2 pounds of barytes were required for the production of 1 pound of lithopone during 1919.

Column 7 shows that the average cost of zinc materials for all companies was $0.0124 per pound of lithopone, or 21.72 per cent of the total factory cost as shown in column 8. Zinc is seen to be the most expensive material entering into the cost of lithopone. Column 9 shows that the average cost of sulphuric acid per pound of lithopone for the year was $0.0029, or 5.08 per cent of the total factory cost as shown in column 10. Column 11 shows all other materials entering into the manufacture of lithopone. Under this heading is included coal used in reduction of barytes and various minor chemicals used principally in the purification of zinc liquor before it is used to make lithopone. The average cost of all other materials for 1919 was $0.0027 per pound of lithopone, or 4.73 per cent of the factory cost as shown in column 12.

It should be pointed out that the variation by companies of a given material cost per pound of lithopone and the percentage of factory cost do not necessarily follow each other. One firm may show a low unit cost for a given material, but the percentage of factory cost due to that material may be higher than the percentage shown by another firm with a higher unit cost.

DETAILS OF FACTORY OVERHEAD CHARGES.

TABLE 43.—*Details of factory overhead compared by percentages with total factory cost of lithopone during 1919, by companies.*

[Costs are per pound. Per cent is of total factory cost.]

1	2	3	4	5	6	7	8	9
Plant No.	Total factory cost.	Total factory overhead.		Details of factory overhead.				
		Cost.	Per cent.	Works expense.	Bags and barrels.	Fixed charges.	Laboratory.	Administration.
1	$0.0509	$0.0203	39.89	$0.0147	(1)	$0.0015	(1)	$0.0041
2	.0514	.0151	29.38	.0062	$0.0016	.0031	$0.0001	.0041
3	.0563	.0218	38.72	.0147	.0019	.0029	.0002	.0021
4	.0550	.0166	30.18	.0099	.0013	.0034	.0003	.0017
5	.0543	.0228	41.99	.0155	.0023	.0039	.....	.0011
6	.0581	.0208	35.80	.0163	.0021	.0004	.0006	.0014
7	.0624	.0201	32.21	.0141	.0018	.0034	.....	.0008
8	.0639	.0121	18.93	.0097	.0024	(1)	(1)	(1)
9	.0686	.0324	47.23	.0302	.0016	.0005	.0001	.....
10	.0674	.0276	40.95	.0214	.0025	.0009	.0007	.0021
11	.0688	.0274	39.83	.0221	.0026	.0009	.0006	.0012
WEIGHTED AVERAGE OF ALL COMPANIES.								
First quarter, 1919	.0604	.0239	39.57	.0168	.0016	.0025	.0002	.0028
Second quarter, 1919	.0548	.0191	34.85	.0126	.0012	.0025	.0002	.0026
Third quarter, 1919	.0548	.0182	33.22	.0124	.0016	.0018	.0002	.0022
Fourth quarter, 1919	.0588	.0213	36.22	.0153	.0020	.0018	.0003	.0019
Year	.0571	.0204	35.73	.0142	.0016	.0021	.0002	.0023

[1] Not shown separately but is included in works expense.

Table 43 shows the details of factory overhead compared with total factory cost of lithopone during 1919 by individual plants. This table also shows average factory overhead charges for all companies during each quarter and for the entire year of 1919. The total factory cost and factory overhead per pound of lithopone by companies have been discussed in the preceding pages.

Column 4 shows that the average factory overhead of all plants during 1919 was 35.73 per cent of the total factory cost. It should be pointed out at this point that since some of the plants do not show factory overhead in the same detail as shown in this table by columns 5 to 9, the total factory overhead is the only fair basis of comparison between plants. Although in many cases the units under detail of factory overhead can not be used for direct comparison, the table shows the variation in the detail to which the various plants distribute their overhead expense.

Column 5 showing works expense includes such items as indirect labor, fuel, power, light, and general factory expense. The average works expense for all companies was $0.0142 per pound of lithopone. The costs given under bags and barrels, column 6, is for packages of any kind. Only one plant did not report a separate charge for this item, but included it in works expense. This item is small and fairly uniform for all companies. The average cost for packages during the year was $0.0016 per pound of lithopone.

Fixed charges, column 7, include items of expense such as insurance, depreciation, and State and local taxes. In all cases but one the charge reported is an actual expense and not an estimated one. One firm included fixed charges in works expense. The average of all plants reporting such charge for 1919 was $0.0021 per pound of lithopone. Column 8 shows the expense due to maintenance of a chemical laboratory. This charge was shown separately by seven plants. In all cases the charge for laboratory was small.

Administration charges as shown in column 9 represents salaries paid to executives and general office expense. The charges vary greatly with the size of the organization, but as the charge is relatively small it has little effect on the total cost of lithopone. The methods used by various companies in arriving at administrative expenses are practically the same as the methods used in determining sales expense, namely, actual expense, percentage of sales price, or a fixed sum per unit of product.

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INTRODUCTION.

This pamphlet presents a discussion of the crude botanical drugs [illegible] with special reference to those foreign and domestic articles of [illegible] importance in the drug trade. It is No. 39 of the Tariff Information Series, which the United States Tariff Commission is publishing as an aid to the study of the tariff and an understanding of facts in the domestic industries.

The report is divided into two parts and an appendix.

Part 1—the Summary drugs are defined and classified, and the world trade, production, and consumption of these articles are discussed. A brief review of tariff treatment and policy is also presented.

Part 2—*General Information and Statistics of Individual Drugs*—This part classifies drugs according to their geographical source and is concerned with the principal imported articles and those which have been or may probably be cultivated commercially in the United States.

Appendix.—The portions of the tariff act of 1913 relating to crude drugs are cited.

In the preparation of this report the Tariff Commission has had the assistance of Mr. E. E. Stanford, assisted by Mr. [illegible] Lyons, of the members of the Commission's staff. The Commission desires to make acknowledgment to the Bureau of Chemistry and the Bureau of Agriculture, through whose courtesy it has secured data relating to this work for the Commission.

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SUMMARY

THE CRUDE BOTANICAL DRUG INDUSTRY.

SUMMARY.

Definition:

Drugs are organic or inorganic substances that are used as medicines or in the preparation and composition of medicines. The term "drug" as commonly used, however, is an extremely loose one and has been subjected to various interpretations. It formerly was held to refer to any substance used in any chemical process, and was generally inclusive of spices, condiments, and natural dyeing and tanning materials, as well as substances used for the treatment of disease. The federal food and drug act of June 30, 1906, under section 6, provides a more restricted definition:

> The term "drug" as used in this act shall include all medicines and preparations recognized in the United States Pharmacopoeia or National Formulary for internal or external use, and any substance or mixture of substances intended to be used for the cure, mitigation, or prevention of disease of man or other animals.

This definition was applied by the Court of Customs Appeals in the interpretation of the word "drugs" as used in paragraph 477 of the tariff act of 1913.[1]

The common interpretation of the word to-day includes not only the medicinals outlined under the above definition, but also a wide variety of more or less crude materials of plant origin, such as gums, balsams, essential oils, perfume materials, and various other products which have some medicinal use, but which are chiefly used for manufacturing or technical purposes. The most important medicinals and their principal nonproprietary combinations are legally standardized as to identity, strength, and purity by the United States Pharmacopoeia and the National Formulary.

Classification:

For the purposes of this publication all drugs may be divided into six classes, the boundary lines of which, however, are not clearly defined.

These classes and their corresponding provisions in the tariff act of 1913 are as follows (paragraphs referred to are given in the Appendix, see page 62):

---

[1] U. S. v. Maine Central R. R. Co., et al., 7 Ct. Cust. Appls., 114, 117.

1. The natural and uncompounded drugs, chiefly of vegetable origin, such as the balsams, barks, beans, berries, gums, roots, leaves, seeds, and fruits of numerous plants. These drugs in either a crude or advanced state are enumerated by nature or origin in the provisions of paragraphs 9, 27, and 477. Other articles of this class are given specific mention in the following paragraphs: 28, 36, 39, 40, 233, 235, 388, 402, 409, 410, 437, 454, 473, 516, 519, 541, 544, 558, 592, and 595.
2. Alkaloids, glucosides, and other medicinal principles, usually of a definite chemical character, and derived by manufacturing processes from materials within the scope of Class 1, above. (Pars. 5, 13, 18, 31, 47, 70, 584, 591, 594, and 616.)
3. Miscellaneous natural or manufactured substances, such as certain expressed and essential oils, usually of definite origin and character, but not chemical individuals. (Pars. 43, 44, 45, 46, 442, 543, and 561.)
4. Compounded medicinals and pharmaceutical preparations, consisting of mixtures, extracts, tinctures, pills, etc., and including the majority of proprietary medicinals, both alcoholic and nonalcoholic. (Pars. 5, 16, 17, and 249.)
5. Antitoxins, serums, vaccines, and other so-called biological products, chiefly of animal or bacterial origin. (Par. 400.)
6. Organic and inorganic chemical compounds used in medicine, such as alcohol, chloroform, ether, Epsom salts, and Glauber salts, corrosive sublimate, etc., and the coal-tar and other complex chemical medicinals (sometimes termed "synthetics"). Many of these have predominant use in the chemical and technical industries. (Pars. 1, 8, 14, 15, 18, 19, 29, 35, 38, 42, 65, 67, 144, 421, 515, 548, 585, 617, and 635.) Medicinals of coal-tar origin are provided for in Group III of Section 500 of Title V of the act of September 8, 1916.

The present discussion is concerned primarily with vegetable drugs and especially with those in the crude state as produced by cultivation or collected from wild plants. (Class 1 above.) Such medicinals include many of the most important items of the modern materia medica; as examples of primary importance there may be cited crude opium, cinchona, nux vomica, belladonna, digitalis, and senna. Articles of this type, unground and untreated except for the "curing" by drying or otherwise which may be necessary for the proper packing and prevention of decay or deterioration pending shipment and manufacture, are known as crude botanical drugs. These must usually be further treated or compounded with other materials before being used in medicine.

World Trade in Crude Botanical Drugs.

Trade in crude drugs is as ancient as commerce. The superstitious materia medica of the past reached out into unknown corners of the earth for unknown products which derived their chief value from the mystery of their origin. The search for drugs and spices was not the least of the spurs that led to the discovery of the New World. Thousands of plant species have had more or less medicinal vogue. Even now when scientific tests have discarded hosts of valueless medicinals, there is hardly a country which does not furnish some commercial medicinal supply. In former times the drug trade of the world was centered in Hamburg, Germany, and this port largely controlled the commerce in Northern Europe and Asia. Trieste was an

important port for the drug trade of Southern Europe and Northern Africa, and India served as a center for Oriental medicinals. London and Marseilles are centers for their respective countries, and London has now taken, in large part, the former preeminence of Hamburg. New York is the one great port for American domestic, import and export trade, and if its importance attained in the recent war continues, it appears probable that New York will eventually overshadow in importance all foreign ports.

Production of Drugs in Foreign Countries.

In general, it may be said that crude-drug production, from a commercial or agricultural viewpoint, is a relatively unimportant industry. The principal exceptions are the cultivation of opium and cinchona. Drug cultivation has been carried on more or less extensively in Germany and Austria, and to some extent in Italy and Spain. In each of these countries and also in Southern Russia large quantities of drugs are annually collected from wild plants. The majority of European botanicals are gathered thus by the cheapest of peasant labor—old men, women, and children. During the war renewed interest in drug cultivation was manifested in the allied countries. An especially notable feature was the rapid growth of the industry in Japan. There it has been fostered by very favorable climatic conditions, by cheap skilled agricultural labor, and, to some extent at least, by governmental aid. The newly founded Japanese chemical industries have also become prominent in the manufacture of a number of plant alkaloids and extracts. Present reports indicate that Japan in the future will be an important source of botanical drugs.

Domestic Drug Production Under War Conditions.

Experimental cultivation of a number of crude drugs has been carried on for a number of years by the United States Department of Agriculture, colleges of pharmacy, agricultural experiment stations, and by a few drug firms. Upon the outbreak of the war and the partial or complete cutting off of imported supplies, the prices of crude drugs rose to unprecedented heights. Army demands accelerated the upward trend. The influenza epidemic in the United States and abroad called for enormous quantities of drugs. Drug cultivation attracted considerable popular interest, and efforts were made at once to cultivate several indispensable drugs which appeared suited to American climatic conditions. Considerable success has been reported with two important medicinals, belladonna and digitalis, and also with cannabis indica, the drug obtained from Indian hemp. Henbane, stramonium, valerian, and Levant wormseed, all important drugs, have been cultivated with varying success, and the cultivation of others has been undertaken on an experimental scale. Stimulation in the collection of wild drugs, for reasons which will be noted later, was less successful.

Present Status and Probable Future of American Drug Cultivation.

Climatic, labor, and other conditions will doubtless preclude the cultivation in the United States of many large staples, such as opium, coca leaves, cinchona, and nux vomica. There was an overproduction of some of the drugs cultivated during the war and in many cases this resulted in low prices and consequent loss to the growers. Cultivation and preparation of botanical drugs requires a high degree of specialized agricultural and technical skill and experience, valuable land, some special appliances, and a class of labor which is much more expensive in this country than abroad. The scope of the industry is further limited by the exacting climate and soil requirements of most of these crops, by liability to insect and disease damage, and by a comparatively small demand, which in most cases is limited by necessity and can not be stimulated as can the demand for foodstuffs or manufactured products. The possible renewal of low-priced imported supplies has been a constant menace to the domestic industry. American-grown drugs, in general, are more carefully produced, better standardized, and of higher commercial value than were the prewar imports.

The cultivation of these crops in the United States is not likely to be successful except in the hands of specialists having adequate equipment for the proper curing of the crop and possessing special knowledge of the botanical and chemical characteristics of the drug plants. In many cases the quality of the product must be controlled by chemical analyses or animal experimentation. These exacting requirements have been met in the case of certain indispensable drugs, and because of the high prices and absence of foreign competition during the war, their cultivation has been commercially successful. The growers maintain, however, that this cultivation can not be continued after competition with foreign wild products is resumed.

Consumption of Crude Botanical Drugs.

Many articles which are important in medicine have large or predominant use in other connections; for example, licorice is largely used for flavoring plug tobacco, and camphor in the manufacture of celluloid. Considerable quantities of certain drugs, such as santonin, are used in veterinary medicines or stock feeds. The chief channel of consumption of the crude botanical drugs, however, is in the preparation of medicines for the treatment of human disease.

Many important drugs, such as opium, coca leaves, cinchona, nux vomica, belladonna, ipecac, and henbane, owe their therapeutic value to contained alkaloids. The purification of these alkaloids forms an important branch of the drug industry, in which Germany before the war had shown some preeminence. The United States, England,

France, Holland, Java, Switzerland, and Japan also have well-developed alkaloid industries. Large-scale domestic production is limited to the cinchona and opium alkaloids, and to cocaine, strychnine, caffeine, emetine, and hydrastine.

Two general channels of consumption of drug products for human medicinal use may be indicated, although in some instances there is no clear line of demarcation: (1) Prescriptive medicine, in which drugs are prescribed and used under the supervision of a physician. (2) So-called "patent" or proprietary medicine largely used for self-medication. The composition, especially the percentage content of patent medicines, is rarely made known except when required by law. Exceptions may be cited in the class known as "ethical proprietaries," whose formulæ are made known to physicians, to whom they are chiefly advertised. The use of proprietary mixtures containing narcotics, whether so labeled or not, has been proved to result in numerous cases of drug addiction. Constant supervision is also needed to guard against intoxicants masquerading as proprietary medicinals.

In spite of restrictive legislation, the manufacture of proprietaries shows a constant growth. In 1914, 2,903 establishments, with a product value of $102,463,374, were listed by the Bureau of the Census as manufacturers of proprietaries. This represented an increase in product value of 22.3 per cent since 1909 and of 214.1 per cent over that of 1889. The value of patent medicines, compounds, and subsidiary products accounted for about three-fifths of the entire value of products reported by the industries engaged in manufacture of medicines, druggists' preparations, and perfumery and cosmetics. Of the above product value, $83,455,264, or 83.5 per cent, represents strictly medicinal articles, the remainder representing fire-extinguisher compounds, insecticides, etc. The value of druggists' preparations, which includes material for prescriptive medicine, is given at $49,375,739 for 1914. While comparative statistics are lacking, it may be safely assumed that America now leads the world in manufactured medicines.

Although no cost data have been gathered by this Commission, it may be said that the cost of crude drugs, ranging widely as it does from a few cents to less than one one-hundredth cent per medicinal dose, is usually immaterial as compared with the cost of solvents (especially alcohol), labor, manufacturing processes, advertising, and other overhead expenses. The actual cost of an available crude drug has comparatively little effect on its use in legitimate medicine, which is, therefore, unlikely to be affected by a rate of duty at all comparable with those of the past. The choice and amount of drugs used in secret and proprietary medicines, on the other hand, is more apt to be determined by comparative cost. Many drugs, notably

those of the "bitter," "tonic," and "blood purifier" types have been largely used in the past in the manufacture of proprietary compounds of the "pure vegetable product" type, whose actual effect depended in many cases on alcohol and advertising. The sale of such nostrums has been considerably curtailed by the food and drugs act with the Sherley amendment, the Harrison narcotic law as amended, the Volstead Prohibition Act, and various postal laws.

Tariff Treatment and Policy.

In past tariff acts it has been the general policy of Congress to maintain differentials between crude drugs, ground or advanced drugs, and purified or manufactured medicinals, such as alkaloids and compounded medicines.

Grinding is usually the first step in the preparation of medicinals and in the United States drug grinding is practiced both by firms which carry on no further manufacture and by manufacturers of alkaloids and medicinal preparations. While the tariff differential was presumably established for the benefit of the domestic drug-grinding industry, its additional effect in hindering imports of products liable to sophistication should not be overlooked. Adulteration in ground drugs is very difficult to detect and this as well as the tariff differential has tended to develop a preference in the trade for the crude and unground product. The present differential of 10 per cent ad valorem is practically prohibitive of the entry of expensive ground drugs but would hardly be calculated to keep out cheaper materials.

It is not always easy to differentiate between the crude and the advanced product. Paragraph 477 of the free list provides for "natural and uncompounded drugs in a crude state, not advanced in value or condition by shredding, grinding, chipping, crushing, or any other process or treatment beyond that essential to the proper packing of the drugs and the prevention of decay or deterioration pending manufacture." This does not necessarily require the drug to be in its crudest state of occurrence and the initial process or manipulation to obtain the material by itself in the form of an article of commerce does not constitute an advance in value or condition. For example, the Court of Customs Appeals has held that gum resin reclaimed from turpentine, dirt, leaves, and insects had not been advanced in value or condition. (U. S. *v.* Sheldon, 2 Ct. Cust. Appls., 485, 490, and 492.)

The differential between the crude and ground products is not maintained in the case of drugs which are specifically mentioned either on the dutiable list (Schedule A) or on the free list. Specific enumeration permits entry of the crude and advanced drugs at the same rate. Thus the provisions for aconite, ipecac, balm of Gilead,

cocculus indicus, jalap, manna, nux vomica, salep, buchu leaves, cardamom seeds, etc., include the articles in any form or condition under the respective names. Nearly all of the drugs specifically mentioned in the free list of the act of 1913, if not so enumerated, would presumably be classified as crude articles under paragraph 477, or as advanced articles under paragraph 27, or as alkaloids or medicinal compounds under paragraph 5. If the scheme of statistical tabulation recently worked out by a committee representing the executive departments concerned should be adopted, the collection of import statistics will no longer be conditioned upon specific mention in the tariff law. Among the articles the specific mention of which might then be discontinued are: aconite, asafetida, cinchona bark, dandelion roots, ipecac, jalep, and nux vomica.

The mention of certain drugs appears to be traditional only; they are to-day of little or no medicinal or commercial importance and might well be omitted. No imports of balm of Gilead and salep have been reported in recent years. Burgundy pitch, cocculus indicus, dandelion and marshmallow roots are also quite unimportant. As in the case of the articles mentioned in the preceding paragraph, such omission, under a law otherwise similar to the present one, would probably not alter the actual revenue status of future imports should any be received.

For tariff consideration crude botanical drugs may be divided into three classes:

(1) Exotic drugs not commercially produced in the United States.
(2) Exotic drugs whose production in this country has been carried on under war conditions.
(3) Indigenous drugs, not produced to any important extent elsewhere than in the United States.

The last class presents no tariff problems since there are no imports.

In the act of 1913 several largely imported and valuable exotic drugs were singled out for specific tax. As these have not been commercially producible in the United States, except at high cost, the raising of revenue may be presumed to be the sole reason. The duty on these articles ranges from one-fourth cent (on gentian) to 10 cents per pound (on buchu leaves and ergot).

The annual revenue from an individual drug varies from a few dollars to over a million dollars. (Revenue collected on crude opium in 1915 was $1,059,018. See Table 2 on p. 21.) Import statistics indicate that the rate of duty has been without influence on the volume of imports, and a consideration of the actual imposition per medicinal dose indicates no serious burden on individual consumers. The prices of different commodities vary greatly, but $4 per pound

may be taken as a limit which is rarely passed by a crude drug. A pound represents from 250 to 7,000 medicinal doses.

In the case of drugs largely used for the manufacture of alkaloids, a rate sufficient to preserve the approximate equivalence between the crude article and its equivalent in alkaloid, if deemed advisable, could be worked out separately for each article. A duty based on the cost of manufacture would, however, have to be determined by separate inquiry since these costs vary considerably for the different products.

Competition was rarely evident between American medicinals and those produced abroad and heretofore the American crude botanical drug industry appears not to have been considered in tariff legislation. Exotic botanical medicinals were not commercially cultivated in America, either because of unsuitable climate or because American agriculture could not compete with wild or even cultivated materials collected or produced elsewhere by the cheapest classes of labor—old men, women, and children in Europe and coolie labor or its equivalent in Asia and Africa.

In the case of exotic drugs cultivated in the United States, in general, the expense of their production under American conditions so much exceeds their former import prices as to render it very doubtful if their commercial cultivation can persist after normal trade is resumed. While their aggregate value is relatively small, their importance to the public health can hardly be overestimated. Although among the highest priced drugs, their actual cost per dose is insignificant and has comparatively little effect on the prices of the finished medicinals which contain their active principles. They can not be replaced by synthetic medicinals nor can their production be immediately stimulated and secured in emergency as is the case with most of the manufactured products. These products have received little or no attention in previous tariff revisions, but the advisability of their continued cultivation in the United States deserves serious consideration.

GENERAL INFORMATION AND STATISTICS OF INDIVIDUAL DRUGS

GENERAL INFORMATION AND STATISTICS OF INDIVIDUAL DRUGS.

Inasmuch as the factors of production, nature, and use of the individual drugs vary widely, a brief account of the more important articles, and also certain unimportant ones now mentioned in the tariff, is given in the following pages. For the purpose of this presentation, vegetable drugs are divided into three classes, according to their geographic origin and production. These classes are as follows:

(1) Exotic drugs not commercially cultivated in the United States.
(2) Exotic drugs produced by cultivation in the United States.
(3) Indigenous drugs.

I. EXOTIC DRUGS NOT COMMERCIALLY CULTIVATED IN THE UNITED STATES.

SCHEDULE A.

OPIUM.

Production and Trade.

Opium consists of the dried juice of the opium poppy. It is the source of morphine, codeine, heroin, and several other alkaloids. Opium containing less than 9 per cent of morphine has been chiefly used in the preparation of smoking opium; that containing more than 9 per cent is known as medicinal opium. The former was until recent years produced in enormous quantities in India and China, but the traffic is now rigidly restricted in India and supposedly suppressed in China, although governmental vicissitudes have from time to time allowed some recrudescence of cultivation in certain Provinces. The importation of smoking opium into the United States was prohibited in 1909. Asiatic Turkey is the chief source of medicinal opium, which is also produced to a lesser extent in Persia. Persia was the chief source of opium during Turkey's participation in the World War. In Turkey and Persia, opium is produced under exceptionally favorable climatic conditions by cheap but skilled labor. Opium has been produced in many other countries, and experimentally within a wide range throughout the United States, although costs of production here have been found prohibitive. The habit-forming nature of the drug has further served to discourage its cultivation within our borders.

Uses.

Opium is chiefly used for the manufacture of alkaloids, the most important of which are morphine, codeine, and heroin or diacetylmorphine. It owes its therapeutic value chiefly to its content of morphine. Opium and its alkaloids are legitimately used to induce sleep and insensibility to pain, but their continued use entails a serious addiction which often leads to the moral, mental, and physical breakdown of the victim.

Opium Addiction.

As to the prevalence of addiction within the United States, reference may be made to the report of a special committee appointed by the Secretary of the Treasury in 1918,[1] which revealed that the United States consumes from 13 to 72 times as much opium per capita as any other country in which records are available, or about 36 grains (36 medicinal doses) per capita per year. Of 4,092 manufacturers making patent and proprietary medicines and druggists' preparations in 1914, 1,098 reported the use of narcotic drugs, chiefly opium derivatives. Their annual total was, roughly, 352,000 pounds of opium or its equivalent, or nearly 75 per cent of an annual import of 477,000 pounds. It was estimated that about 18,300,000 recorded narcotic prescriptions are filled annually, besides numerous sales of narcotic preparations which were exempt from record under the provisions of the Harrison Act as originally enacted. The number of addicts in the United States is estimated at between 1,000,000 and 2,000,000. The chief cause of addiction is claimed to be medication, as opiates produce in most cases no exhilarent effects comparable to that of alcohol.

Future of the United States Opium Trade.

The future of the opium trade in the United States will be conditioned on the rigid enforcement of regulatory laws. Opium addiction is known to be increasing, and predictions of further increase as a result of alcohol prohibition have been made. The unavoidable use of opium in Army surgery has probably tended to increase the number of addictions, and numerous reports were made of deliberate addiction for the purpose of escaping Army service.

Imports and Prices.

In order to supply the Army needs during the war, legitimate trade in opium was closely controlled by the various Governments. Consumption in the United States was cut because of the reduced supplies, and, presumably, because of the application of the Harrison narcotic law. War conditions and the loss of the Turkish supply

[1] Traffic in Narcotic Drugs. Report of a special committee of investigation appointed Mar. 25, 1918 by the Secretary of the Treasury, Washington, June, 1919.

occasioned a rise in price of crude opium from $6.90 per pound in 1914, to $35 in 1917. High levels were maintained till the spring of 1919, when large shipments of Turkish opium broke the price sharply to near the prewar figure.

Imports of crude opium decreased under war conditions, and those of advanced opium showed a marked increase, owing, doubtless, to its greater economy in shipping space and the great demand which rendered the higher rate of duty a negligible factor in the market. The general imports of crude opium by countries are shown in Table 1 and the imports for consumption in Table 2. Imports of morphine and the other alkaloids of opium are presented in Table 3.

Revenue.

Opium is by far the largest revenue producer of any drug. For the years 1909–1916, crude opium yielded an average annual revenue of $671,968, and the dried grade (1910–1918) of $178,094.

TABLE 1.—*General imports of crude opium, by countries, 1909–1918.*

Imported from—	1909		1910		1911	
	Pounds.	Dollars.	Pounds.	Dollars.	Pounds.	Dollars.
England [1]	217,315	872,129	48,409	191,144	110,589	411,935
Greece						
Turkey in Asia	173,533	616,098	135,957	488,096	239,568	832,277
Turkey in Europe	98,304	373,416	222,950	790,139	225,598	774,642
Portugal						
Italy	750	2,290	3,185	10,100		
France	58	173	32	71		
Persia						
Cuba	5	10				
Germany	21,624	64,473	38,706	142,925	54,087	189,591
All other	5,799	22,929				
Total	517,388	1,951,518	449,239	1,622,475	629,842	2,208,445

Imported from—	1912		1913		1914	
	Pounds.	Dollars.	Pounds.	Dollars.	Pounds.	Dollars.
England	82,782	651,567	61,782	356,971	39,372	161,736
Greece						
Turkey in Asia	132,826	762,745	210,993	1,090,880	222,975	885,517
Turkey in Europe	141,886	797,646	209,413	964,484	160,514	614,838
Portugal						
Italy						
France						
Persia						
Cuba						
Germany	42,343	225,445	26,245	153,630	32,339	148,338
All other						
Total	399,837	2,437,403	508,433	2,565,965	455,200	1,810,429

[1] Shipments from England, Germany and Italy, are reexportations, since these countries are not producers of crude opium.

TABLE 1.—*General imports of crude opium, by countries, 1909–1918*—Continued.

Imported from—	1915		1916		1917	
	Pounds.	Dollars.	Pounds.	Dollars.	Pounds.	Dollars.
England	38,258	234,828	62,665	410,882	65,356	622,363
Greece	2,940	13,460	46,367	274,576	6,138	55,621
Turkey in Asia	212,367	976,234	14,239	54,928	.....	.....
Turkey in Europe	228,162	1,208,767	13,644	64,380	599	4,758
Portugal	.....	.....	4,500	34,166	.....	.....
Italy	2,268	11,631	2,291	18,076	4,285	123,472
France	.....	.....	1,711	15,811	.....	.....
Persia	.....	.....	1,216	6,555	10,257	35,684
Cuba	.....	.....	25	325	.....	.....
Germany	32	85	.....	.....	.....	.....
Canada	.....	.....	.....	.....	177	1,520
All other	.....	.....	.....	.....	.....	.....
Total	484,027	2,445,005	146,658	879,699	86,812	843,418

Imported from—	1918	
	Pounds.	Dollars.
England	126,173	1,951,732
Greece	27,087	422,658
Turkey in Asia	.....	.....
Turkey in Europe	.....	.....
Portugal	.....	.....
Italy	815	42,470
France	1	16
Persia	3,758	26,352
Cuba	.....	.....
Germany	.....	.....
All other	.....	.....
Total	157,834	2,443,228

TABLE 2.—*Imports of opium for consumption in the United States, 1909–1919.*

A.—CRUDE OR UNMANUFACTURED AND NOT ADULTERATED, CONTAINING 9 PER CENT OR OVER OF MORPHIA.

Fiscal year.	Rate of duty.	Quantity.	Value.	Duty collected.	Value per unit.	Average ad valorem rate.
		Pounds.				*Per cent.*
1909	$1 per pound	465,776	$1,831,679	$465,776	$3.93	25.43
1910 [1]	do	44,195	146,932	44,195	3.32	30.08
1910 [2]	$1.50 per pound	367,249	1,306,240	550,873	3.56	42.17
1911	do	502,407	1,644,301	753,610	3.27	45.83
1912	do	384,911	2,020,026	577,367	5.25	28.58
1913	do	441,276	2,130,154	661,914	4.83	31.07
1914 [3]	do	276,985	1,087,236	415,477	3.93	38.21
1914 [4]	$3 per pound	164,636	644,353	493,908	3.91	76.65
1915	do	353,006	1,699,217	1,059,018	4.81	62.32
1916	do	117,870	535,183	353,610	4.54	66.07
1917	do	43,016	330,652	129,048	7.68	39.03
1918	do	21,342	265,283	64,026	12.43	24.13
1919	do	74,264	977,596	222,792	13.16	22.79

[1] Act of 1897—July 1 to Aug. 5, 1909.
[2] Act of 1909—Aug. 6, 1909, to June 30, 1910.
[3] Act of 1909—July 1 to Oct. 3, 1913.
[4] Act of 1913—Oct. 4, 1913, to June 30, 1914.

TABLE 2.—*Imports of opium for consumption in the United States, 1909–1919*—Contd.

B.—DRIED, POWDERED, OR OTHERWISE ADVANCED, CONTAINING 9 PER CENT AND OVER OF MORPHIA.

1910	$2 per pound	27,934	$128,000	$55,869	$4.58	43.65
1911	do	67,962	304,200	135,925	4.48	44.68
1912	do	77,551	641,887	155,102	8.28	24.16
1913	do	49,070	389,864	98,141	7.94	25.17
1914 [3]	do	4,321	28,061	8,643	6.49	30.80
1914 [4]	$4 per pound	27,773	177,623	111,094	6.40	62.54
1915	do	38,977	308,928	155,908	7.92	50.47
1916	do	44,052	243,790	176,208	5.53	72.28
1917	do	77,990	640,563	311,960	8.21	48.70
1918	do	98,498	1,514,127	393,992	15.37	26.02
1919	do	101,989	1,776,787	407,956	17.42	22.96

[3] Act of 1909—July 1 to Oct. 3, 1913.
[4] Act of 1913—Oct. 4, 1913, to June 30, 1914.

TABLE 3.—*Imports of alkaloids of opium for consumption in the United States, 1909–1919.*

A.—MORPHIA OR MORPHINE, SULPHATE OF.

Fiscal year.	Rate of duty.	Quantity.	Value.	Duty collected.	Value per unit.	Average ad valorem rate.
		Ounces.				*Per cent.*
1909	$1 per ounce	152	$392	$152	$2.57	38.88
1910 [1]	do	32	66	32	2.06	48.48
1910 [2]	$1.50 per ounce	13,050	60,071	19,575	4.60	32.59
1911	do	20,345	95,067	30,517	4.67	32.10
1912	do	13,825	78,891	20,737	5.71	26.29
1913	do	24,797	141,221	37,195	5.70	26.34
1914 [3]	do	4,235	9,822	6,352	2.32	64.68
1914 [4]	$3 per ounce	1,570	4,398	4,710	2.80	107.10
1915	do	1,383	3,300	4,149	2.38	125.73
1916	do	2,685	8,906	8,055	3.31	90.44
1917	do	5,584	22,675	16,752	4.06	73.88
1918	do	25,215	202,263	75,645	8.02	37.40
1919	do	25,370	158,307	76,110	6.24	48.08

B.—ALL OTHER ALKALOIDS OF OPIUM AND SALTS AND ESTERS THEREOF.

1909	$1 per ounce	3,779	$10,106	$3,779	$2.67	37.39
1910 [1]	do	1,100	2,558	1,100	2.33	43.00
1910 [2]	$1.50 per ounce	21,870	63,406	32,805	2.90	51.76
1911	do	480	2,545	720	5.30	28.31
1912	do	634	1,742	951	2.75	54.60
1913	do	9,672	28,587	14,508	2.96	50.75
1914 [3]	do	7,086	39,371	10,629	5.56	27.00
1914 [4]	$3 per ounce	4,507	25,157	13,521	5.58	53.75
1915	do	8,626	49,584	25,573	5.74	52.19
1916	do	2,360	9,981	7,080	4.22	70.93
1917	do	34,179	165,028	102,537	4.82	62.13
1918	do	20,479	126,882	61,437	6.19	48.42
1919	do	56,895	318,361	170,685	5.60	53.61

[1] Act of 1897—July 1 to Aug. 5, 1909.
[2] Act of 1909—Aug. 6, 1909, to June 30, 1910.
[3] Act of 1909—July 1 to Oct. 3, 1913.
[4] Act of 1913—Oct. 4, 1913, to June 30, 1914.

COCA LEAVES AND COCAINE.

Production and Trade.

Coca leaves are chiefly imported from Peru, where the plant has been cultivated since prehistoric time. Large plantations are being developed in Java. Experimental cultivation is reported from Florida. The plant is very sensitive to frost. It could probably be grown in our tropical possessions, but the grave moral menace of its use renders any such introduction inadvisable.

Uses.

Coca leaves are used almost wholly in the manufacture of the alkaloid, cocaine, which occurs in amounts from 0.5 to 1 per cent. After removal of the cocaine large amounts of coca leaves are used in the manufacture of soft drinks. The use of coca leaves by addicts is hardly known in the United States, but is almost universal in some South American countries.

The habitual use of cocaine is one of our most serious narcotic problems, as the habit is easily established and is more vicious in its effects than any other narcotic. The committee (referred to under Opium, see p. 19) reports that 75 per cent of the cocaine used in the United States is consumed by addicts. The annual import of leaves is equivalent to about 150,000 ounces of cocaine.

The chief legitimate use of cocaine is as a local anaesthetic. Its habit-forming tendencies have stimulated endeavors to produce non-habit-forming synthetic substitutes. Many of these are successful for certain purposes, but as yet have not wholly replaced cocaine—a result very much to be desired. Many of these substitutes were formerly in the control of German firms. During the war, by the provisions of the trading with the enemy act, the principal one, "novocaine," was licensed for manufacture in the United States as "procaine." The use of cocaine is conditioned by legal restrictions similar to those affecting morphine.

Prices.

Coca leaves normally sold for about 25 to 30 cents per pound, but the quotations for 1919 were about double this figure. Cocaine hydrochloride, which sold for about $2.75 per ounce in 1914, was quoted at over $11 during 1918, and this high level of prices continued during 1919 and the first half of 1920.

Imports and Revenue.

Imports of coca leaves are remarkably uniform in quantity for a drug product, and have shown no appreciable variation with a change in the rates of duty. The high duty on the alkaloid, cocaine, however, has largely limited its normal import to a few rare salts not produced here. As a revenue producer coca leaves rank next to opium among the drug products not used for technical purposes. The average revenue for the period 1911 to 1919 was $79,057. Imports of coca leaves and its alkaloids are shown in Tables 4 and 5.

TABLE 4.—*Imports of coca leaves for consumption in the United States, 1909–1919.*

[1] Act of 1897—July 1 to Aug. 5, 1909.
[2] Act of 1909—Aug. 6, 1909 to June 30, 1910.
[3] Act of 1909—July 1 to Oct. 3, 1913.
[4] Act of 1913—Oct. 4, 1913 to June 30, 1914.

TABLE 5.—*Imports of cocaine, ecgonine, and salts and derivatives for consumption in the United States, 1909–1919.*

[1] Act of 1897—July 1 to Aug. 5, 1909
Act of 1909 Aug. 6, 1909 to June 30, 1910.
Act of 1909—July 1 to Oct. 3, 1913.
[4] Act of 1913—Oct. 4, 1913 to June 30, 1914.

LICORICE ROOT.

Production and Trade.

Licorice root, in amount the largest of drug imports, is obtained chiefly from Asia Minor, the Levant, and Southern Europe. The licorice plant has been introduced into America, and thrives under our climatic conditions, even on poor land and with little agricultural care. Before the war, however, the cost of harvesting precluded commercial production of this normally extremely cheap product in America. Some domestic production has been reported but is believed to be on a more or less experimental scale. Licorice is chiefly used for the manufacture of licorice paste, of which over 90 per cent is used for flavoring plug tobacco, the remainder being utilized in pharmaceuticals and confections.

War trade restrictions on licorice root, and the decreasing duty on licorice paste have tended to favor the importation of the more concentrated commodity, although the root is still predominant. The root

contains the equivalent of about 20 per cent of licorice extract. During the war a number of substitutes for licorice are understood to have been developed for use in tobacco manufacture.

Imports and Revenue.

Imports of licorice root in normal times came chiefly from Turkey in Asia and Asiatic and European Russia. War conditions seriously affected this trade. For 1918 only 27,051,021 pounds valued at $1,863,886 were received, whereas for the years 1909–1919 the average annual import was 76,066,186 pounds and the value $1,866,092.

American imports of licorice paste are contributed chiefly by Spain. Much smaller amounts are received from Italy and still less from France. Revenues have, generally speaking, decreased with the diminution in rate of duty. For the years 1909 to 1913 they averaged $22,244; for the years 1914 to 1919, $10,329. Imports of licorice root and extract are given in Tables 6 and 7.

TABLE 6.—*Imports of licorice roots in a crude state for consumption in the United States, 1909–1919.*

Fiscal year.	Rate of duty.	Quantity.	Value.	Duty collected.	Value per unit.	Average ad valorem rate.
		Pounds.				*Per cent.*
1909	Free	9[illegible]76	$1,628,894		$0.017	
1910	do	8 35	1,365,576		.017	
1911	do	12 23	2,060,571		.016	
1912	do	7 70	1,309,819		.018	
1913	do	10 29	1,806,756		.017	
1914[1]	do	3 05	611,907		.019	
1914[2]	½ cent per pound	5 39	914,150	$135,942	.017	14.67
1915	do	8 10	1,537,442	205,723	.018	13.21
1916	do	5 42	1,792,573	131,960	.033	7.36
1917	do	5 44	2,189,441	148,496	.036	6.78
1918	do	2 21	1,863,886	67,627	.068	3.63
1919	do	4 61	3,426,007	106,612	.060	3.11

[1] Act of 1909—July 1 to Oct. 3, 1913. [2] Act of 1913—Oct. 4, 1913, to June 30, 1914.

TABLE 7.—*Imports of licorice extracts, in paste, rolls, or other forms, for consumption in the United States, 1909–1919.*[1]

Fiscal year.	Rate of duty	Quantity	Value.	Duty collected.	Value per unit.	Average ad valorem rate
		Pounds.				*Per cent.*
1909	4½ cents per pound	520,046	$82,907	$23,420	$0.121	37.23
1910[2]	do	128,562	14,913	5,785	.116	38.80
1910[3]	2½ cents per pound	714,638	88,356	17,865	.124	20.22
1911	do	835,268	115,531	20,981	.139	18.07
1912	do	934,892	117,114	23,367	.125	19.95
1913	do	796,222	101,823	19,905	.128	19.55
1914[4]	do	139,357	18,045	2,483	.129	19.31
1914[5]	1 cent per pound	788,136	101,596	7,861	.129	7.74
1915	do	1,055,646	149,302	10,556	.141	7.07
1916	do	1,702,927	230,129	17,029	.135	7.40
1917	do	1,158,300	253,671	11,563	.219	4.56
1918	do	734,876	229,812	7,348	.312	3.20
1919	do	413,848	213,028	4,139	.514	1.94

[1] Small quantities imported for manufacture in bond and on which duty was remitted have not been included.
[2] Act of 1897—July 1 to Aug. 5, 1909.
[3] Act of 1909—Aug. 6, 1909, to June 30, 1910.
[4] Act of 1909—July 1 to Oct. 3, 1913.
[5] Act of 1913—Oct. 4, 1913, to June 30, 1914.

Prices.

Licorice extract was not quoted in the trade journals before 1916. The price in July, 1916, was 48 cents per pound and rose to a dollar in October, 1918. The powdered extract was quoted at 80 cents per pound in April, 1920. Licorice stick has ranged in price from 23 cents per pound in 1915 to 83 cents in 1919. Crude licorice root was quoted at 14 cents to 16 cents per pound in April, 1920.

ERGOT.

Production and Trade.

Ergot is the product of a fungus disease of rye, and occurs sporadically wherever rye is grown, notably in Minnesota and the Dakotas and in Spain and Russia. Ergot has important and legitimate uses especially in obstetric practice, but is also used criminally to produce abortion. On account of its poisonous nature complete removal from the rye is essential. Since the ergot grains are normally two or three times as large as rye grains, practically complete removal is effected by screening. The ergot thus removed is, however, mixed with other refuse matter, and efforts to concentrate it for drug use have not proved commercially profitable in the United States. Commercial supplies come principally from Spain and Russia, where it is hand-picked from the rye screenings. The Spanish production, according to a recent consular report (June 18, 1920) amounted to 87 metric tons in 1919 as compared with only 6 tons in 1918, and 30 tons in 1917. Although mills grinding rye endeavor to remove all of the ergot, the separation is not always perfect, owing to defective machinery, careless operatives, or the presence of broken or unusually small grains of ergot. Manufactured cereal products containing more than one-tenth of 1 per cent of ergot are considered adulterated under the food and drugs act. (U. S. D. A., Service and Regulatory Announcements, Chemistry 11, item 25, Dec. 31, 1914.) All feed products containing injurious amounts of ergot are likewise considered adulterated. (*Loc. cit.* 15, item 149, Dec. 4, 1915.) While attempts at intentional propagation have not been wholly successful, any high rate of duty markedly increasing prices might incite such attempts, causing loss to neighboring rye growers and resulting in the presence of dangerous amounts of ergot in rye flour and feed products. Obviously such results would be detrimental to the interests of the public health.

Imports.

Imports which come principally from Russia and Spain have averaged about 150,000 pounds. They have varied somewhat in amount since ergot is usually dependent on seasonal conditions in the producing countries. Imports for consumption are shown in Table 8.

TABLE 8.—*Imports of ergot for consumption in the United States, 1909–1919.*

Fiscal year.	Rate of duty.	Quantity.	Value.	Duty collected.	Value per unit.	Average ad valorem rate.
		Pounds.				*Per cent.*
1909	Free	135,740	$36,651		$0.270	
1910	do	181,614	52,911		.291	
1911	do	141,334	75,592		.535	
1912	do	207,138	187,500		.905	
1913	do	223,793	208,364		.931	
1914 [1]	do	22,326	16,256		.728	
1914 [2]	10 cents per pound	163,378	86,384	$16,337	.529	18.91
1915	do	141,915	92,459	14,191	.651	15.35
1916	do	123,015	73,896	12,301	.600	16.65
1917	do	165,701	80,647	16,570	.487	20.55
1918	do	140,474	81,267	14,047	.578	17.29
1919	do	116,813	149,890	11,681	1.283	7.79

[1] Act of 1909—July 1 to Oct. 3, 1913. [2] Act of 1913—Oct. 4, 1913, to June 30, 1914.

Prices.

Declared value for imported ergot in 1909 was 27 cents per pound, in 1912, 93 cents, and in 1919, $1.28 per pound. American wholesale prices have also been very irregular and have ranged between 54 cents per pound in June, 1914, and $5 in April, 1920.

GENTIAN.

Gentian, the most important bitter medicinal, is a wild product of the mountainous regions of southern Europe. Neither there nor in America has its commercial cultivation proved successful. Gentian and other bitters are widely used in tonic proprietary medicines, which chiefly owe their tonic effect to the alcohol contained.

Imports.

Gentian is the largest American drug root import save licorice and the largest whose use is solely as a drug. For the years 1909 to 1919 an average annual amount of 1,268,801 pounds with an average value of $75,207 is reported. Gentian has been dutiable at one-fourth cent per pound since October, 1913, and since that time has produced an average annual revenue of $2,300 (see Table 9).

TABLE 9.—*Imports of gentian for consumption in the United States, 1909–1919.*

Fiscal year.	Rate of duty.	Quantity.	Value.	Duty collected.	Value per unit.	Average ad valorem rate.
		Pounds.				*Per cent.*
1909	Free	1,485,389	$62,445		$0.042	
1910	do	1,177,433	42,356		.036	
1911	do	1,537,919	56,902		.037	
1912	do	1,585,612	67,837		.043	
1913	do	1,796,928	88,281		.049	
1914 [1]	do	831,493	40,164		.048	
1914 [2]	¼ cent per pound	1,350,442	68,955	$3,376	.051	4.90
1915	do	1,022,252	55,553	2,555	.054	4.60
1916	do	788,307	63,240	1,970	.080	3.12
1917	do	1,780,044	218,377	4,450	.122	2.04
1918	do	412,590	46,516	1,031	.112	2.22
1919	do	188,402	26,653	471	.141	1.75

[1] Act of 1909—July 1 to Oct. 3, 1913. [2] Act of 1913—Oct. 4, 1913, to June 30, 1914.

Prices.

American wholesale prices from 1912 through 1915 showed little variation, the maximum being 8¾ to 9½ cents per pound in 1915. During 1916 the price rose to 28 cents, but soon declined, and at the end of 1919 was quoted at 13½ to 14 cents.

SARSAPARILLA.

Sarsaparilla is the root of several species of wild vines found in the forests of tropical America. It has been introduced for cultivation in India and Jamaica, but supplies from these colonies rarely reach the United States. It is commonly used in so-called "blood purifiers" of the proprietary type, and does not rank high in therapeutic favor. It may be but is seldom used in the "sarsaparilla" soft drinks. During the war it was replaced to some extent by the underground stem and roots of several indigenous plants, particularly by the so-called "American sarsaparilla," which is the root of a botanically unrelated plant collected in the Southern Appalachians. Mexican internal disturbances and shipping difficulties have greatly increased the price of sarsaparilla.

Imports.

American imports of sarsaparilla have decreased considerably in recent years. The annual average of the period, 1909–1919, was 319,038 pounds, valued at $42,615. Imports of sarsaparilla are shown in Table 10.

TABLE 10.—*Imports of sarsaparilla for consumption in the United States, 1909–1919.*

Fiscal year.	Rate of duty.	Quantity.	Value.	Duty collected.	Value per unit.	Average ad valorem rate.
		Pounds.				*Per cent.*
1909	Free	570,124	$52,937	.....	$0.093	.....
1910	....do	560,858	59,786	.....	.107	.....
1911	....do	379,091	43,849	.....	.116	.....
1912	....do	452,917	51,428	.....	.114	.....
1913	....do	301,308	38,360	.....	.127	.....
1914 [1]	....do	71,228	8,447	.....	.119	.....
1914 [2]	1 cent per pound	153,742	27,837	$1,537	.181	5.52
1915	....do	250,178	36,055	2,501	.144	6.94
1916	....do	291,276	41,489	2,912	.142	7.02
1917	....do	146,047	18,994	1,460	.130	7.69
1918	....do	110,709	31,454	1,107	.284	3.52
1919	....do	221,946	58,126	2,219	.261	3.82

[1] Act of 1909—July 1 to Oct. 3, 1913. [2] Act of 1913—Oct. 4, 1913, to June 30, 1914.

Prices.

Since 1912 prices of Mexican sarsaparilla have ranged from 9–10 cents per pound in April, 1915, to 41–43 cents in April, 1920. Sarsaparilla from Honduras has increased in price from about 30 cents per pound in 1912 to 80 cents in 1920.

BUCHU LEAVES.

Buchu leaves are a product of British South Africa, used in proprietary medicines and in the treatment of certain genito-urinary diseases. No effort to grow buchu leaves in the United States appears to have been made. America, however, is the largest single consumer of buchu leaves, using from one-half to four-fifths of the total output.

Imports.

Buchu is one of the more important crude-drug imports. For the years 1910–1919 an average annual amount of 110,081 pounds, valued at $95,547 was received. Imports of buchu leaves are given in Table 11.

TABLE 11.—*Imports of buchu leaves for consumption in the United States, 1909–1919.*

Fiscal year.	Rate of duty.	Quantity.	Value.	Duty collected.	Value per unit.	Average ad valorem rate.
		Pounds.				*Per cent.*
1909	Free	.....	$45,559	.....	.....	.....
1910	....do	130,644	48,652	.....	$0.372	.....
1911	....do	106,345	81,658	.....	.768	.....
1912	....do	181,121	160,608	.....	.887	.....
1913	....do	105,310	114,632	.....	1.090	.....
1914 [1]	....do	18,362	20,860	.....	1.136	.....
1914 [2]	10 cents per pound	107,006	109,492	$10,700	1.023	9.77
1915	....do	120,704	115,689	12,070	.959	10.43
1916	....do	94,520	85,061	9,452	.900	11.11
1917	....do	100,809	85,807	10,080	.851	11.75
1918	....do	50,685	42,431	5,068	.837	11.95
1919	....do	85,303	90,578	8,530	1.061	9.42

[1] Act of 1909—July 1, to Oct. 3, 1913. [2] Act of 1913—Oct. 4, 1913, to June 30, 1914.

Prices.

Wholesale prices of buchu leaves from 1912 to 1918 showed little variation, averaging about $1.20 per pound. In January, 1919, the price rose to $2.60 to $2.75 and this high level was maintained throughout the year.

BALSAMS.

"Balsam" is a trade term applied to various more or less odoriferous oleoresins. Resins and oleoresins, including those commercially classed as balsams, are exudations of plants, sometimes occurring naturally in cavities in the plant, or obtained by wounding the plant. The balsams are used for medicinal purposes, in perfumery and cosmetics, and for various technical purposes. By chemical authorities the term, "balsam," is restricted to oleoresins containing benzoic or cinnamic acids or their derivatives. Of chief commercial and therapeutic importance are copaiba, tolu, and Peru balsams. The first-named is not, chemically speaking, a balsam. Copaiba and tolu are products of South American trees, and Peru balsam, of a tree occur-

ring in Salvador, Central America. Copaiba is used in certain varnishes, and is a common ingredient of "quack" medicines for the treatment of genito-urinary and venereal disease. Peru balsam is used in plasters and ointments. Tolu balsam is a common ingredient of cough syrups, and is also used in chewing gums and cheap confectionery. Canadian balsam, an oleoresin collected in Quebec and northern Maine, is used in printing inks and in medicinal plasters. Oregon balsam, a similar but much cheaper product from the States of the Pacific Northwest, is much used as a substitute in printing ink.

Imports.

Statistics of imports and revenue for crude copaiba, Peru, tolu, and Canadian balsams are shown in Tables 12–15. Advanced balsams are rarely imported.

TABLE 12.—*Imports of copaiba balsam for consumption in the United States, 1909–1919.*

Fiscal year.	Rate of duty.	Quantity.	Value.	Duty collected.	Value per unit.	Average ad valorem rate.
		Pounds.				*Per cent.*
1909	Free	234,257	$73,095	.....	$0.312	.....
1910	do	208,566	66,279	.....	.318	.....
1911	do	191,154	56,918	.....	.298	.....
1912	do	159,172	50,969	.....	.320	.....
1913	do	206,447	66,361	.....	.321	.....
1914 [1]	do	64,520	20,561	.....	.319	.....
1914 [2]	10 per cent	180,915	50,778	$5,077	.281	10.00
1915	do	273,616	59,921	5,992	.219	10.00
1916	do	204,464	70,868	7,086	.347	10.00
1917	do	308,545	124,122	12,412	.402	10.00
1918	do	373,362	202,847	20,284	.580	10.00
1919	do	300,659	130,967	13,097	.435	10.00

[1] Act of 1909—July 1 to Oct 3, 1913.

[2] Act of 1913—Oct. 4, 1913, to June 30, 1914.

TABLE 13.—*Imports of Peru balsam for consumption in the United States, 1909–1919.*

Fiscal year.	Rate of duty.	Quantity.	Value.	Duty collected.	Value per unit.	Average ad valorem rate.
		Pounds.				*Per cent.*
1909	Free	25,843	$24,217	.....	$0.936	.....
1910	do	50,363	49,132	.....	.976	.....
1911	do	37,910	47,840	.....	1.262	.....
1912	do	47,862	63,800	.....	1.335	.....
1913	do	48,996	61,702	.....	1.260	.....
1914 [1]	do	19,518	24,870	.....	1.270	.....
1914 [2]	10 per cent	5,503	4,831	$483	.878	10.00
1915	do	27,506	32,735	3,273	1.190	10.00
1916	do	40,657	112,270	11,227	2.761	10.00
1917	do	58,933	175,355	17,535	2.975	10.00
1918	do	44,082	115,035	11,504	2.609	10.00
1919	do	64,879	163,568	16,357	2.521	10.00

[1] Act of 1909—July 1 to Oct. 3, 1913.

[2] Act of 1913—Oct. 4, 1913, to June 30, 1914.

TABLE 14.—*Imports of tolu balsam for consumption in the United States, 1909–1919.*

Fiscal year.	Rate of duty.	Quantity.	Value.	Duty collected.	Value per unit.	Average ad valorem rate.
		Pounds.				*Per cent.*
1909	Free	39,668	$5,589	.....	$0.141	.....
1910	....do	46,946	7,178	.....	.152	.....
1911	....do	21,802	8,328	.....	.153	.....
1912	....do	30,970	7,256	.....	.234	.....
1913	....do	57,277	29,552	.....	.516	.....
1914 [1]	....do	14,066	8,139	.....	.579	.....
1914 [2]	10 per cent	28,072	10,924	$1,092	.389	10.00
1915	....do	39,750	13,993	1,399	.352	10.00
1916	....do	63,579	17,233	1,723	.271	10.00
1917	....do	62,820	18,255	1,825	.291	10.00
1918	....do	49,869	23,996	2,399	.481	10.00
1919	....do	58,194	44,603	4,460	.766	10.00

[1] Act of 1909—July 1 to Oct. 3, 1913. [2] Act of 1913—Oct. 4, 1913, to June 30, 1914.

TABLE 15.—*Imports of Canadian fir balsam for consumption in the United States, 1909–1919.*

Fiscal year.	Rate of duty.	Quantity.	Value.	Duty collected.	Value per unit.	Average ad valorem rate
		Pounds.				*Per cent.*
1909	Free	4,673	$2,375	.....	$0.508	.....
1910	....do	16,645	8,432	.....	.507	.....
1911	....do	15,788	7,128	.....	.451	.....
1912	....do	3,741	1,741	.....	.465	.....
1913	....do	3,691	1,827	.....	.495	.....
1914 [1]	....do	80	62	.....	.775	.....
1914 [2]	10 per cent	13,784	12,443	$1,214	.903	10.00
1915	....do	18,610	14,636	1,463	.786	10.00
1916	....do	7,113	3,934	393	.537	10.00
1917	....do	4,176	3,897	389	.933	10.00
1918	....do	3,698	1,404	140	.380	10.00
1919	....do	2,344	2,140	214	.913	10.00

[1] Act of 1909—July 1 to Oct. 3, 1913.
[2] Act of 1913—Oct. 4, 1913 to June 30, 1914.

Prices.

The prices for copaiba balsam have shown but little variation, averaging about 50 cents per pound. Peru has increased in price from about $1.50 per pound in 1912 to $5.50 during the first part of 1920. Prices of tolu have varied considerably since 1912. It was quoted at $1.65 per pound in October, 1912, but for most of 1915, 1916, and 1917 it averaged only about 40 cents. Since January, 1918, the price has been in the neighborhood of $1.50 per pound. Canadian balsam is usually sold by the gallon, and has ranged in price from $3.75 per gallon in April, 1912, to $16 per gallon in April, 1920. Oregon balsam, prior to 1918, was quoted at 75 cents to $1 per gallon. The price has since increased to about $1.50–$2 per gallon.

FREE LIST.

CINCHONA BARK.

Production and Trade.

Cinchona bark, which is the source of the important alkaloid, quinine, is the bark of several species of the genus *Cinchona*, native to South America, whence the bark was introduced to medicine in the seventeenth century. The forests of South America were the only source of supply until about 1850, when their destruction by wasteful collection seemed imminent and led to commercial attempts at cultivation, chiefly in Bolivia, India, Ceylon, Jamaica, and Java. Cultivation in South America and Jamaica was not economically successful. In India and Java cultivation established before 1860 has continued to the present day. Ceylon led in the world market for a time, but following enormous overproduction in 1887 Ceylonese cinchona culture was almost abandoned. Since that time Dutch interests in Java have virtually monopolized the world's supply. Although important quantities are produced in India under Governmental auspices, little from this source enters the world trade. Javan cinchona culture was established and fostered by the Dutch Government. In former years the bark was wholly exported, chiefly via Amsterdam, but more recently extensive quinine factories have been established in Java. The Java industry, which controls 90 per cent of the world's supply of bark, is under centralized control. The success of the monopoly may be attributed to Governmental aid, favorable climatic and soil conditions, cheap labor, and the development (through cultivation and selection) of varieties yielding bark far richer in alkaloids than the South American wild product. International trade was regulated till the opening of the World War by the International Quinine Cartel, a close association of Dutch, German, and British manufacturers. French and American firms were prevented from formally participating in the agreement because of the antitrust laws of France and the United States. After the opening of the war, the cinchona and quinine situation was virtually under the dictation of the Dutch Government through the Kina Bureau, with headquarters in Amsterdam. This bureau consists of three representatives of the planters, three of the quinine manufacturers, and an outside chairman. The Governments of the various importing countries rigorously controlled the imports, use, and sale of forthcoming supplies of cinchona bark. English firms at one time were reported to have gained extensive holdings in Java, but later reports indicate that these holdings are insufficient, even with increased Indian production, to satisfy the requirements of the British Empire. In 1919 there were 120 Dutch planters and 6 British. The former control ten-elevenths and the latter one-eleventh of the total Javan production. The recent tendency of

the Dutch combine has been to restrict bark exports and to sell the product as crude quinine. The growth of quinine manufacture in Japan has been rapid, but that country also is dependent on Java for bark. Much interest has been manifested in possible renewal of supplies from South America, where the discovery of new forests has been reported. Experimental cultivation in the Philippines has been undertaken, but offers no prospects of commercial importance in the near future. The tree is not hardy in the United States proper. Former German plantations in East Africa are now under British control, but are still on a small scale. The immediate future of quinine production appears therefore under Dutch control.

Uses.

Cinchona bark is used chiefly in the manufacture of its alkaloids, of which quinine is of most importance. The alkaloid content of commercial bark runs from 5 to 8 per cent; the proportion of quinine varies with the variety, being usually from two-thirds to three-fourths of the total alkaloids. Cinchona and its alkaloids are indispensable in the treatment and prevention of malarial fever, and are also used extensively in colds and similar affections. They were in much demand during the influenza epidemic. The crude bark and the alkaloids other than quinine (chiefly cinchonine, cinchonidine, and quinidine) are also used extensively in proprietary medicine.

Prices.

During recent years prices for cinchona bark have ranged from about 20 cents in 1912 to over $1 per pound during 1918. Prices decreased somewhat during 1919 and in April, 1920, the red quills of cinchona bark were quoted at 70 to 80 cents per pound. Quinine sulphate, the most important salt of the principal alkaloid, increased in price from 26 cents per ounce in January, 1915 to 90 cents during 1919 and the first quarter of 1920. Cinchonidine sulphate was quoted at 16 cents per ounce in August, 1914 and has gradually increased until in April, 1920 the price was 88 cents per ounce. Similarly the price of cinchonine sulphate has risen from 7 cents per ounce in August, 1914 to 45 cents in April, 1920.

Imports.

Cinchona bark is one of our largest medicinal imports, averaging (1909–1919) about 3,500,000 pounds, valued at $500,000. Since it is on the free list it yields no revenue. General imports by principal countries are given in Table 16 and imports for consumption are shown in Table 16a. Imports of cinchona alkaloids are given in Table 17.

TABLE 16.—*Imports by countries of cinchona bark, or other bark from which quinine may be extracted, 1909–1918.*

Imported from—	1909		1910		1911	
	Pounds.	Dollars.	Pounds.	Dollars.	Pounds.	Dollars.
Netherlands	3,422,181	254,475	3,052,371	221,572	3,768,935	292,704
United Kingdom	15,531	1,388	41,812	3,399	19,233	1,238
Germany	64,711	7,249	206,300	17,116	37,880	3,692
Total	3,502,423	263,112	3,300,483	242,087	3,826,048	297,634

Imported from—	1912		1913		1914	
	Pounds.	Dollars.	Pounds.	Dollars.	Pounds.	Dollars.
Netherlands	2,840,477	228,560	3,493,945	351,520	3,618,968	461,247
United Kingdom	32,733	2,439	29,684	2,689	11,637	1,312
Germany	18,305	2,302	9,610	745	18,043	1,827
All other	308	22	20,000	2,536	220	26
Total	2,891,823	233,323	3,553,239	357,490	3,648,868	464,412

Imported from—	1915		1916		1917	
	Pounds.	Dollars.	Pounds.	Dollars.	Pounds.	Dollars.
Netherlands	2,912,242	556,220	3,657,273	726,906	2,329,664	633,679
United Kingdom	8,147	904	283,623	49,817	191,683	50,540
Peru	19,913	3,353	3,874	323	927	124
Germany			933	226		
All other	4,247	629	1,617	365	9,123	1,588
Total	3,944,549	561,106	3,947,320	777,637	2,531,397	685,936

Imported from—	1919	
	Pounds.	Dollars.
Germany		
Netherlands	655,382	178,879
United Kingdom	85,414	34,721
Panama	29,120	10,192
Ecuador	13,852	672
Peru	100,646	34,235
China	191,185	47,853
Dutch East Indies	2,193,561	502,620
All other	4,468	1,600
Total	3,273,628	810,775

TABLE 16a.—*Imports of cinchona bark (or other barks from which quinine may be extracted) for consumption in the United States, 1909–1919.*

Fiscal year.	Rate of duty.	Quantity.	Value.	Value per unit.
		Pounds.		
1909	Free	3,502,385	$263,112	$0.075
1910	do	3,385,894	255,703	.077
1911	do	4,136,354	341,896	.083
1912	do	2,935,359	239,182	.081
1913	do	3,389,973	354,593	.105
1914	do	3,651,968	464,411	.127
1915	do	3,951,196	561,802	.142
1916	do	3,947,320	777,637	.196
1917	do	2,531,397	685,936	.271
1918	do	3,131,958	779,403	.249
1919	do	3,866,158	803,081	.208

TABLE 17.—*Imports of cinchona alkaloids and salts for consumption in the United States, 1909–1919.*

Year.	Rate of duty.	Cinchonidia.		Quinia, sulphate of.		All other.	
		Ounces.	Dollars.	Ounces.	Dollars.	Ounces.	Dollars.
1909	Free	60,332	11,590	2,065,765	285,125	204,207	40,357
1910	do	229,243	46,886	2,345,472	318,375	337,481	32,646
1911	do	17,272	4,219	2,469,082	347,241	615,840	58,942
1912	do	136,197	14,183	2,368,840	361,111	539,201	91,802
1913	do	309,395	43,680	2,279,734	397,409	648,865	131,692
1914	do	205,006	19,502	2,224,765	486,641	452,292	117,915
1915	do	69,487	8,223	1,508,931	378,511	203,330	66,004
1916	do	131,481	15,814	1,409,228	1,022,821	231,100	82,167
1917	do	221,272	17,590	623,947	324,138	418,366	143,004
1918	do	86,482	20,708	1,256,172	593,019	104,050	44,309
1919	do	86,000	25,495	2,101,006	1,238,125	1,147,102	272,631

NUX VOMICA.

Nux vomica is the seed of a tropical tree produced in India and Cochin China. It is used in the manufacture of its alkaloids, of which strychnine is of chief importance. Strychnine is a valuable heart remedy, and is also used extensively for poisoning vermin. Large quantities of nux vomica are employed in the manufacture of its alcoholic tincture and of proprietary remedies of the "bitter" and "tonic" class.

Imports.

Imports of nux vomica come chiefly from India. In 1914, British India furnished 93 per cent of the total imports. In amount nux vomica is one of the largest American drug imports; for the years 1909–1919 an average annual amount of 2,881,075 pounds, valued at $87,548, was reported. Imports for consumption are shown in Table 18.

TABLE 18.—*Imports of nux vomica for consumption in the United States, 1909–1919.*

Fiscal year.	Rate of duty.	Quantity.	Value.	Value per unit.
		Pounds.		
1909	Free	1,006,957	$27,370	$0.016
1910	do	2,738,062	35,170	.013
1911	do	4,331,402	58,183	.013
1912	do	2,427,187	37,782	.016
1913	do	2,346,735	39,380	.017
1914	do	1,891,672	32,983	.017
1915	do	2,245,338	51,507	.022
1916	do	4,355,904	134,336	.030
1917	do	2,445,984	86,018	.035
1918	do	2,739,814	111,711	.040
1919	do	4,548,710	348,559	.077

Prices.

The prewar price for nux vomica averaged about 5 cents per pound for the whole seed and 7 to 8 cents for the powdered. During 1917 prices practically doubled, and although falling off somewhat

during 1919, the whole seeds were quoted at 13 to 14 cents per pound in April, 1920, and the powdered at 18 to 19 cents.

IPECAC.

Ipecac is a root imported from Colombia, Brazil, and Panama. It is a high-priced medicinal, valued in bronchial diseases as an emetic and as the source of the alkaloid, emetine. Both ipecac and emetine are used in diseases caused by amoebae. Ipecac of American commerce is the wild product of the South American forests and attempts to cultivate it in other tropical countries have usually been unsuccessful. However, in India and in the Straits Settlements small scale cultivation is maintained.

Imports.

Imports, which are shown in Table 19, averaged 85,023 pounds, valued at $157,366, for the period 1909–1919.

TABLE 19.—*Imports of ipecac for consumption in the United States, 1909–1919.*

Fiscal year.	Rate of duty.	Quantity.	Value.	Value per unit.
		Pounds.		
1909	Free	35,166	$27,945	$0.795
1910	do	36,261	29,738	.820
1911	do	27,654	36,522	1.320
1912	do	41,627	59,828	1.440
1913	do	56,648	86,113	1.580
1914	do	78,654	110,316	1.400
1915	do	137,927	248,408	1.801
1916	do	203,734	484,828	2.379
1917	do	84,672	146,505	1.730
1918	do	60,972	122,281	2.005
1919	do	171,944	378,512	2.202

Prices.

Wholesale prices of Cartagena (Colombian) ipecac ranged from $1.45 per pound in 1912 to $4.25 during the first part of 1919. In April, 1920, this variety of ipecac was quoted at $3.25 per pound. The Rio (Brazilian) ipecac has followed about the same range.

ACONITE.

Aconite is a root imported from Southern Europe; a closely related species comes from Japan. The leaves of the same plant, although of less value, are also used to some extent. Aconite is a cardiac sedative and the source of the alkaloid, aconitine, one of the most poisonous substances known. It is an important medicinal, though used only in small quantities.

TABLE 20.—*Imports of aconite for consumption in the United States, 1911–1919.*

Fiscal year.	Rate of duty.	Quantity.	Value.	Value per unit.
		Pounds.		
1911	Free	7,959	$613	$0.077
1912	do	21,385	1,721	.080
1913	do	12,946	1,065	.082
1914	do	4,267	321	.075
1915	do	8,821	962	.109
1916	do	6,720	538	.080
1917	do	34,285	8,721	.254
1918	do	475	119	.250
1919	do	22,320	4,462	.200

Imports.

Imports (see Table 20) are small and variable. Before the war aconite came chiefly from Germany and Austria-Hungary, but during the war supplies have been derived from Japan and Spain. The Japanese product is not identical with the European and is not recognized by the U. S. Pharmacopoeia, IX.

Prices.

Aconite root sold for 13 to 15 cents per pound before the war and the leaves were quoted at 7 to 8 cents. In April, 1916, the price of the former rose to 50–75 cents and this level obtained during 1917, 1918, and 1919. In April, 1920, aconite root was quoted at 75–85 cents per pound.

ASAFETIDA.

Asafetida is an ill-smelling gum-resin from the Asiatic deserts. It is marketed chiefly via England and India and is used in nervous diseases.

Imports.

Imports are quite variable in amount and value; for the years 1909–1919 an average annual amount of 92,011 pounds, valued at $43,934, was reported (see Table 21).

Prices.

Owing to its very variable character prices of asafetida cover a wide range. For the years 1912–1919 the wholesale price has ranged between 35 cents and $4 per pound. Asafetida in lump form was quoted at $3.50 and the powdered asafetida at $4.50 per pound in April, 1920.

TABLE 21.—*Imports of asafetida for consumption in the United States, 1909–1919.*

MANNA.

Manna is the dried juice of the manna ash which is cultivated in Sicily. It is an important medicinal in the tropical Americas, Porto Rico being the chief American market. It is used as a laxative and as a source of the sugar, mannite. Tagua-nut waste is a more important but recently developed source of this little-used sugar.

Imports.

For the years 1909–1919 an annual import of 63,474 pounds valued at $29,965 was received. In 1914 almost 99 per cent of the imports came from Italy. Imports are shown in Table 22.

TABLE 22.—*Imports of manna for consumption in the United States, 1909–1919.*

Prices.

The price of manna has not varied appreciably since 1912. The large flakes have averaged about 90 cents per pound and the small flakes about 60 cents per pound.

JALAP.

Jalap is the dried root of a plant which is native to Mexico and cultivated both in that country and in India. Jalap is one of the more important cathartic medicinals.

Imports.

Imports come wholly, or virtually so, from Mexico and in recent years have fluctuated largely both in quantity and value. For the years 1909–1919, imports (see Table 23) averaged 169,977 pounds valued at $30,188.

TABLE 23.—*Imports of jalap for consumption in the United States, 1909–1919.*

Fiscal year.	Rate of duty.	Quantity.	Value.	Value per unit.
		Pounds.		
1909	Free	66,096	$15,096	$0.228
1910	do	199,905	38,030	.190
1911	do	239,679	61,415	.256
1912	do	119,211	27,607	.232
1913	do	277,275	44,632	.161
1914	do	208,901	23,942	.115
1915	do	176,047	18,485	.105
1916	do	201,383	13,642	.067
1917	do	168,639	14,315	.084
1918	do	126,511	34,238	.270
1919	do	95,103	40,667	.428

Prices.

From 1912–1919, prices of jalap have ranged from 8–10 cents per pound in 1915 to 75–80 cents in October, 1919. The price quoted in April, 1920, was 60–75 cents per pound.

DANDELION ROOT.

Dandelion root is an unimportant bitter medicinal which is used in tonics and "blood purifiers," chiefly of proprietary nature. It is collected for commerce more or less extensively in Germany, Switzerland, Austria, and France, from both wild and cultivated plants. The plant has become a pestiferous weed in the United States and is not cultivated here for drug use.

Imports.

For the period of 1909–1919 the average annual imports are 86,292 pounds, valued at $12,013. Imports for consumption are shown in Table 24.

TABLE 24.—*Imports of dandelion root for consumption in the United States, 1909–1919.*

Fiscal year.	Rate of duty.	Quantity.	Value.	Value per unit.
		Pounds.		
1909	Free	47,884	$3,058	$0.034
1910	do	35,919	2,436	.068
1911	do	72,223	4,717	.065
1912	do	97,942	7,372	.075
1913	do	108,434	8,269	.076
1914	do	109,658	9,389	.086
1915	do	112,811	12,137	.107
1916	do	29,378	6,487	.220
1917	do	108,713	23,912	.219
1918	do	149,088	37,773	.253
1919	do	77,165	16,600	.215

Prices.

Wholesale prices of imported dandelion root have ranged from 9½ cents per pound in 1912 to 40 cents in 1917. Prices in 1919 dropped to about 25 cents. In April, 1920, the foreign product was quoted at 22–23 cents per pound and the domestic at 21–22 cents.

MARSHMALLOW OR ALTHEA ROOTS, LEAVES, AND FLOWERS.

Marshmallow or althea roots, leaves, and flowers are mucilagenous drugs, formerly imported from Germany, but since the war, from Italy, Spain, and France. As medicinal agents they are of negligible importance though occasionally used as demulcents and in poultices. Marshmallow root although no longer used in the manufacture of "marshmallow" confectionery, was the original mucilagenous constituent from which this product received its name. The use of marshmallow root in confectionery has now been largely replaced by such substances as gum arabic.

Imports.

Imports from 1911 to 1916 averaged only about 5,000 pounds, valued at less than $1,000. Since 1917 imports have increased greatly, for 1917–1919 the average annual import was 19,962 pounds, valued at $5,995. (See Table 25.)

TABLE 25.—*Imports of marshmallow or althea for consumption in the United States, 1910–1919.*

Fiscal year.	Rate of duty.	Quantity.	Value.	Value per unit.
		Pounds.		
1910	Free	50	$8	$0.160
1911	do	3,380	301	.089
1913	do	4,270	538	.126
1914	do	6,049	514	.085
1915	do	6,645	1,209	.182
1916	do	7,242	1,936	.267
1917	do	23,120	5,846	.252
1918	do	24,246	6,824	.281
1919	do	12,519	5,316	.425

Prices.

Wholesale prices of the whole althea root have ranged in recent years from 16 cents per pound in 1914 to 50 cents in 1916. The cut root was quoted at 22–25 cents per pound in January, 1914, and increased in price to 80–82 cents in January, 1919. The price of whole althea root in April, 1920, was 25–27 cents per pound.

CARDAMOM SEEDS.

Cardamom seeds are the dried seeds of an Indian plant and are used chiefly as an aid to the action of other drugs in cordials and tonics. India itself is the chief consuming country. The largest exports from South India were in 1914–15 and amounted to 5,850

tons. Of these the United Kingdom took 49 per cent, Ceylon 36 per cent, and Germany 15 per cent.

Imports.

From 1909 to 1919 imports, which come principally from India and East Indies, averaged 144,528 pounds valued at $78,149. (See Table 26.)

Prices.

Cardamom seeds have not shown any great price fluctuation since 1912, ranging usually between 60 cents and $1.25 per pound.

TABLE 26.—*Imports of cardamom seed for consumption in the United States, 1909–1919.*

Fiscal year.	Rate of duty.	Quantity.	Value.	Value per unit of quantity.
		Pounds.		
1909	Free	104,981	$45,612	$0.434
1910	do	126,267	51,740	.410
1911	do	94,398	45,788	.485
1912	do	81,964	47,403	.578
1913	do	113,461	104,287	.919
1914	do	80,782	72,148	.893
1915	do	152,679	106,180	.695
1916	do	225,687	119,162	.528
1917	do	214,464	88,605	.413
1918	do	255,318	108,605	.425
1919	do	139,808	70,114	.502

COCCULUS INDICUS.

Cocculus indicus is a poisonous berry, imported from India and used to a slight extent in ointments for the destruction of skin parasites.

Imports.

Since cocculus indicus is imported most frequently as "fish berries," it is difficult to obtain accurate statistics of importation. Imports classified as cocculus indicus have been very small and of practically no significance.

Prices.

The prewar price of cocculus indicus was about 3 cents to 5 cents per pound. This price doubled during the last quarter of 1917, and steadily increased until in July, 1919, it was quoted at 85 cents to $1 per pound. By April, 1920, however, the price had dropped to 25–30 cents.

SALEP OR SALOP.

Salep or salop is a mucilaginous root which constitutes an important article of food in Asia Minor. It is sometimes prescribed in the diet of invalids, but its use is obsolete in American practice.

Imports.

For the years 1912–1915 a total value of $3,035 is reported for the imports. No import statistics since 1915 are recorded. Neither import value per pound nor domestic wholesale prices are available.

BALM OF GILEAD.

Balm of Gilead is a resinous juice formerly used in medicine and cosmetics, but now obsolete in American commerce. Neither price nor import statistics are available.

DRUGS NOT SPECIALLY PROVIDED FOR IN THE TARIFF ACT BUT FOR WHICH IMPORT STATISTICS ARE AVAILABLE.

SENNA.

Senna leaves are obtained from two closely related shrubs, one occurring wild in Egypt (Alexandria senna) and the other cultivated in India (Tinnevelly senna). It is used as a mild cathartic, and is one of the most important drugs of its class. A pound corresponds to 100–120 medicinal doses.

Production.

Senna is not produced commercially within the territorial limits of the United States, but an attempt to cultivate it in Texas about 1905 has been noted. The crop is dependent on cheap labor and a tropical climate. The chief centers of production are in Northern Africa, Arabia, and India. The senna of the two former countries is the product of wild plants, and is collected in the deserts by the natives. Indian senna, on the other hand, is extensively cultivated, and under war conditions a considerable increase of production took place. Extreme adulteration, caused by higher prices, together with Indian and English export restrictions, greatly upset the market, and a considerable decrease in acreage is said to have resulted.

Imports.

Senna is the largest American drug leaf import, both in quantity and value. For the years 1909–1919 an average annual amount of 2,936,846 pounds, valued at $333,309, is reported. In 1914 Egypt furnished 42.2 per cent of the imports, British India 34.7, England 18.1, and the remainder came from France, Germany, and Italy. Imports are shown in Table 27.

TABLE 27.—*Imports of senna leaves for consumption in the United States, 1909–1919.*

Fiscal year.	Rate of duty.	Quantity.	Value.	Value per unit.
		Pounds.		
1909	Free	2,159,553	$99,856	$0.046
1910	do	2,564,452	129,229	.050
1911	do	3,063,275	143,846	.047
1912	do	3,164,003	154,012	.049
1913	do	2,634,117	150,554	.057
1914	do	2,454,772	173,054	.070
1915	do	2,180,288	209,313	.096
1916	do	2,794,400	361,881	.129
1917	do	5,161,315	844,733	.166
1918	do	3,575,066	771,067	.216
1919	do	2,554,069	628,852	.246

Prices.

Tinnevelly senna has ranged in price from 6–12 cents per pound in 1912 to a maximum of 27–37 cents in 1916, and at the end of 1919 was quoted at 14–20 cents. Alexandria senna has ranged from 22 cents to $1.20 a pound during this period. In April, 1920, Tinnevelly senna leaves were quoted at 15–20 cents per pound and the whole Alexandria leaves at 85 cents to $1 per pound.

ALOES.

Aloes is the dried juice of a tropical plant and is commonly classed as a gum. Several varieties are known, but the most common is imported from Curaçao, Dutch West Indies. Aloes is a cathartic, and is an ingredient of many proprietary pills. Aloes is produced in the West Indies (Curaçao aloes); in northwestern Africa (Socotrine aloes), and in southern Africa (Cape aloes). No production in the United States is reported.

Imports.

Imports are of crude aloes, and for the years 1909 to 1919 an average annual import of 1,059,299 pounds, valued at $85,351, was received. (See Table 28.)

Prices.

Prices vary greatly for the four different varieties of aloes. True Barbados aloes is the most costly, averaging about $1 to $1.25 per pound. Socotrine aloes formerly sold for about 25 cents per pound, but during 1919 and early 1920 the price has been in the neighborhood of 80–90 cents. Curaçao and Cape aloes both sell for about 10–15 cents per pound.

TABLE 28.—*Imports of aloes for consumption in the United States, 1909–1919.*

Fiscal year.	Rate of duty.	Quantity.	Value.	Value per unit.
		Pounds.		
1909	Free	671,257	$40,963	$0.060
1910	do	944,[illegible]67	57,6[illegible]	.060
1911	do	9[illegible],305	71,644	.070
1912	do	6[illegible],229	52,733	.079
1913	do	9[illegible],279	77,9[illegible]	.086
1914	do	9[illegible],472	64,983	.071
1915	do	953,186	90,681	.095
1916	do	1,[illegible]97,[illegible]11	152,146	.095
1917	do	1,2[illegible],381	97,[illegible]07	.079
1918	do	1,2[illegible],[illegible]95	95,[illegible]46	.077
1919	do	1,544,940	137,[illegible]57	.089

RHUBARB.

Medicinal rhubarb, which differs botanically from the common garden species, is the underground stem and root of several plants of Chinese origin. Efforts to cultivate medicinal rhubarb outside of China have not been commercially successful. Rhubarb is a laxative and cathartic, being especially valued in ailments of children.

Imports.

Imports of rhubarb root have averaged about 150,000 pounds, valued at approximately $18,000 (1909–1919). Imports are shown in Table 29.

TABLE 29.—*Imports of rhubarb for consumption in the United States, 1909–1919.*

Prices.

For the years 1912 to 1920 prices of the dried rhubarb have ranged from 13½ cents per pound in January, 1916, to $1.80 in October, 1919. The high dried roots in April, 1920, were quoted at $1.20 per pound and the powdered rhubarb at $1.40.

ORRIS ROOT.

Orris root is produced chiefly in Italy and Germany and used in perfumes and dentifrices. An attempt to cultivate orris root generally throughout the United States was made by a private company about 10 to 15 years ago. As an industry, however, it has not developed to any appreciable extent.

Imports.

Orris root is imported almost wholly from Italy. The average imports for the years 1909–1919 were 527,207 pounds, valued at $51,789. (See Table 30.)

TABLE 30.—*Imports of orris root for consumption in the United States, 1909–1919.*

Prices.

The price of the principal grade of orris root (Florentine, whole) has risen from 10 cents to about 30 cents per pound in the period 1912–1919. In April, 1920, the price had decreased to 15–16 cents per pound.

CHAMOMILE FLOWERS.

Chamomile flowers are the dried flowers of several species of plants occurring both wild and cultivated in Germany and elsewhere in Europe. American imports are said to be largely used by German physicians and in proprietary medicines for the diseases of women. This drug has extensive use in Germany and that country utilizes a large portion of her production, besides importing from other European countries. Hamburg is the center of this trade.

Imports.

For the years 1910–1919 an average annual value of $23,822 is reported. Germany and Austria-Hungary were formerly the principal sources of supply, although Belgium, Spain, and Japan have furnished considerable quantities.

Prices.

Several varieties of chamomile flowers are quoted in the New York wholesale drug market. Prices for Roman chamomile flowers have ranged from 15 cents in July, 1914, to $1.50 per pound in October, 1917. Hungarian style chamomile was worth about 10–12 cents before the war and has gradually increased until in April, 1920, it was quoted at 52–54 cents per pound.

TABLE 31.—*Imports of chamomile flowers for consumption in the United States, 1909–1919.*

Fiscal year.	Rate of duty.	Value.	Fiscal year.	Rate of duty.	Value.
1909	Free	$7,528	1915	Free	$13,313
1910	do	19,617	1916	do	[illegible]
1911	do	19,110	1917	do	64,632
1912	do	17,227	1918	do	41,[illegible]
1913	do	14,176	1919	do	14,[illegible]
1914	do	6,252			

COLOMBO ROOT.

Colombo root is a bitter medicinal used for the same purposes as gentian, but it is not an important medicinal. The plant grows wild and is also cultivated in Africa.

Imports.

Imports have been small. For the years 1909–1919 the average annual amount of 21,385 pounds, valued at $1,350, is reported. (See Table 32.)

TABLE 32.—*Imports of colombo for consumption in the United States, 1909–1919.*

Fiscal year.	Rate of duty.	Quantity.	Value.	Value per unit.
		Pounds.		
1909	Free	3,022	$101	$0.033
1910	do	2,288	94	.041
1911	do	8,436	610	.072
1912	do	16,384	613	.037
1913	do	27,565	794	.029
1914	do	4,587	134	.029
1915	do	8,751	458	.052
1916	do	48,867	3,442	.070
1917	do	92,349	4,999	.054
1918	do	20,759	3,061	.147
1919	do	2,195	548	.250

Prices.

The prewar price of colombo root was about 6–8 cents per pound. This was doubled in 1917, and during 1918 and 1919 the price was further increased to about 25 cents per pound. In April, 1920, it was quoted at 15–16 cents.

OTHER FOREIGN DRUGS.

The most important of these will be mentioned under "Exotic drugs cultivated in the United States," which follows. Others of some importance are quassia, chiretta, myrrh, benzoin, guaiac, calamus, triticum, pareira brava, scammony, areca nuts, strophanthus, styrax, and squills. Import statistics for all other drugs, which are grouped in the general classifications, are shown in Tables 33 to 37.

TABLE 33.—*Imports of all other drugs, such as beans, berries, etc., which are natural and uncompounded drugs, not advanced in value or condition, 1909–1919.*

Year.	Rate of duty.	Value.	Year.	Rate of duty.	Value.
1909	Free	$767,183	1914[1]	Free	$726,675
1910	do	736,397	1915	do	680,343
1911	do	841,064	1916	do	1,142,721
1912	do	973,623	1917	do	1,277,783
1913	do	936,750	1918	do	1,710,566
1914	do	390,034	1919	do	770,202

[1]Act of 1913 specifies "not containing alcohol."

TABLE 34.—*Imports of all other drugs, such as beans, berries, etc., which are natural and uncompounded drugs, advanced in value or condition, 1909–1919.*

Year.	Rate of duty.	Quantity.	Value.	Duty collected.	Value per unit.	Average ad valorem rate.
		Pounds.				*Per cent.*
1909	½ cent per pound plus 10 per cent.	625,899	$181,751	$19,739	$0.290	10.86
1910	do	1,512,688	266,483	30,430	.176	10.42
1911	do	1,437,008	147,311	18,323	.103	12.44
1912	do	1,550,039	152,675	19,142	.099	12.54
1913	do	1,313,562	182,732	21,557	.139	11.80
1914	do	1,544,253	104,309	14,291	.068	13.70
1914[1]	10 per cent	1,776,386	113,165	11,316	.065	10.00
1915	do	590,653	72,551	7,255	.122	10.00
1916	do	482,432	79,385	7,938	.164	10.00
1917	do	1,434,577	273,403	27,340	.190	10.00
1918	do	401,624	78,918	7,891	.196	10.00
1919	do	332,850	162,533	16,253	.488	10.00

[1]Act of 1913 specifies "and not containing alcohol."

well as in the United States. It is a perennial, not hardy north of New York, and requires careful handling and cultivation, being very liable to insect and disease damage. The estimated domestic production for 1918 was 166,000 pounds of herb, stems, and leaves, and 22,000 pounds of root. Sixty growers were engaged in cultivation, utilizing a total of 274 acres. Yields of 600 pounds of herb, and 160 pounds of root per acre are reported. California, Michigan, Pennsylvania, and Indiana ranked in acreage in the order given. Destruction of the crop by the potato stalkborer was reported by some California growers. The market is said to have been somewhat oversupplied by domestic production.

Belladonna is valued for its alkaloids, of which, according to the United States Pharmacopœia, the leaves should contain not less than 0.3 per cent and the roots, 0.45 per cent. American cultivation is said to have furnished products considerably above this standard. Atropine and hyoscyamine are the chief alkaloids of belladonna. Atropine is of extreme importance in the surgery of the eye. It is derived chiefly from belladonna, but may also be obtained from certain related plants, particularly scopola, a substitute found in Europe and Japan. The latter has been used extensively in the manufacture of "belladonna plasters," and is believed to be important in the recently developed Japanese manufacture of atropine and related alkaloids.

Imports.

Statistics for imports of belladonna are not given in Commerce and Navigation of the United States, but during the fiscal year 1914 141,074 pounds of leaves and 65,886 pounds of roots were imported.[1] The imports of leaves and roots in 1917 amounted to approximately 33,000 pounds.

Prices.

From 14 cents per pound in 1913 the price of belladonna leaf rose to $1.85 to $2 in 1916; the price of belladonna root increased from 9 cents per pound in 1913 to $3.50 to $5 in 1917. The end of 1919 found the leaf quoted at 30–35 cents per pound and the root at 55–65 cents. This decline is thought to have been caused by the slackening of war demands and the bearish attitude on the part of the trade as much as to actual domestic oversupply or to foreign belladonna which is again appearing on the market. The alkaloid, atropine, was quoted at $55 per ounce during 1917, but since that time prices have fallen off somewhat. In April, 1920, the alkaloid was quoted at about $20 per ounce and atropine sulphate at $15 per ounce.

[1] Import figures for 1914 are given for all drugs and chemicals in Misc. Series No. 82, U. S. Dept. of Commerce.

donna or henbane, but, owing to the lesser demand, it has attracted less commercial attention. Successful production is reported from Virginia, South Carolina, Indiana, Wisconsin, Minnesota, and California, usually in small plats. The plant has also escaped and grows luxuriantly in the mountains of the Pacific Northwest, where considerable quantities were collected during the war. Owing to unfamiliarity of collectors with proper methods of collecting and handling the product, some difficulty was experienced in disposing of this crop. The production in 1917 was estimated at 10,000 pounds. The potency of American digitalis is claimed to be unusually high, and the production of a domestic supply fully equal to the demand is probably conditioned only on stabilization of price at a figure which will allow American producers to grow the plant profitably. In 1914 imports of 22,371 pounds, valued at $1,874, were received. Prices have ranged from 8 cents per pound in 1914 to 90 cents in April, 1916. In April, 1920, domestic digitalis was quoted at 22–25 cents per pound and the imported product at 30–32 cents.

CANNABIS.

Cannabis is usually known as cannabis indica, Indian hemp, or hasheesh (hashish). It was formerly imported exclusively from India, but recent experiments have shown that hemp of equal drug value can be produced in almost any subtropical region. Quantity production has taken place in Virginia and South Carolina, and probably elsewhere in the United States. Because of the high export duty levied by the Indian Government on cannabis the price of the domestic commodity has been considerably lower than that of the imported, although tests have shown the American cannabis to be fully equal to the Indian. American production is believed sufficient to supply all domestic needs. Cannabis is used in medicine to relieve pain and to produce sleep.

Cannabis may be considered, to a certain extent, as a substitute and commercial rival of opium, although the uncertainty of its action has prevented it from becoming as widely used. It produces an intoxication somewhat similar to that of alcohol, but while its habit-forming tendencies are still a matter of dispute, its continued use is admitted to produce mental and physical degeneration. Oriental Governments, especially those of India and Egypt, have found it necessary to regulate its use strictly. Cannabis, however, is the only important narcotic not included in the scope of the Harrison narcotic law. As regards Federal legislation, its use is only limited by the provisions of the food and drugs act, which require statements of its presence on the labels of medicines containing it and a Treasury decision (T. D. 35719), under which it is admitted at the ports on filing of a bond to insure its use for medicinal purposes. This lat-

Prices and Domestic Production.

The price of wormseed has ranged from 19 cents per pound in 1912 to $1.50 in 1916. Levant wormseed was quoted at $1.30 in June, 1920. From a prewar price of $25 per pound, the price of santonin has risen to $175 (June 21, 1920). The high price of santonin and the large field for its use have, therefore, occasioned much interest in the cultivation of Levant wormseed. In America a single firm has experimentally undertaken it, and reports promising results on a small scale.

Imports.

The imports of wormseed are not shown in the published statistics, but in 1914, 81,482 pounds, valued at $24,356, were received principally from Russia and Germany. Imports of the prepared santonin and its salts are shown in Table 38.

TABLE 38.—*Imports for consumption in the United States, 1909–1919.*

A.—SANTONIN AND ALL SALTS OF, CONTAINING 80 PER CENT OR MORE OF SANTONIN (ACTS OF 1897 AND 1909).

Fiscal year.	Rate of duty.	Quantity.	Value.	Duty collected.	Value per unit.	Average ad valorem rate
		Pounds.				*Per cent*
1909	$1 per pound	7,257	$15,549	$7,257	$2.14	46
1910 [1]	do	110	222	110	2.02	49.
1910 [2]	50 cents per pound	7,281	52,553	3,640	7.22	6.
1911	do	4,291	39,678	2,145	9.25	5.
1912	do	3,090	39,956	1,545	12.93	3
1913	do	1,981	44,358	990	22.39	2.
1914	do	1,762	41,674	881	23.64	2.

[1] Act of 1897, July 1 to Aug. 5, 1909. [2] Act of 1909, Aug. 6, 1909, to June 30, 1910.

B.—SANTONIN AND ITS COMBINATIONS WITH ACIDS NOT SUBJECT TO DUTY (AC OF 1913).

		Pounds.				*Per cent*
1914	Free	3,467	$83,454		$24.07	
1915	do	912	25,558		28.02	
1916	do	20,925	586,850		28.04	
1917	do	111	3,966		35.73	
1918	do	223	7,502		33.64	
1919	do	1,125	49,688		44.17	

VALERIAN.

Valerian root is cultivated and also grows wild in England and continental Europe. It is used as a sedative in nervous diseases and i a common ingredient of remedies for the diseases of women. Th plant thrives well under experimental conditions in America, and i understood to have been commercially produced on a small scal Valerian is cultivated on a rather extensive scale in Holland, Bel gium, Germany, France, Austria, England, and Japan. Yields o 2,000 pounds or more of the roots and rhizomes per acre are reported Imports are not shown separately in the official statistics, but i 1914 amounted to 66,233 pounds, valued at $4,357.

TABLE 39.—*Imports of sage for consumption in the United States (1909–1919).*

[1] Act of 1909, July 30, 1913, to Oct. 3, 1913.
[2] Act of 1913, Oct. 4, 1913, to June 30, 1914.
[3] Ground.
[4] Unground.

PYRETHRUM, DALMATIAN, OR INSECT FLOWERS.

Insect flowers have been cultivated for some years in a small way by a single firm in California. They are produced in considerable quantities in Dalmatia, Austria, but in recent years a very extensive cultivation has been carried on in Japan, which country now dominates the world market. As the name indicates, insect flowers are chiefly used as an insecticide, particularly against household and library insects; they are rarely or never used in medicine.

Imports of pyrethrum were not published in Commerce and Navigation of the United States prior to 1916. The rapidly increasing importance of the commodity, however, is shown by the considerable increase in imports, which are given in Table 40. The closed variety of insect flowers increased in price from 32–34 cents per pound in 1914 to 55 cents in 1916. Powdered insect flowers in April, 1920, were quoted at $1 per pound.

TABLE 40.—*Imports of pyrethrum or insecticide flowers for consumption in the United States, 1916–1919.*

Fiscal year.	Rates of duty.	Quantities.	Values.	Value per unit of quantity.
		Pounds.		
1916 [1]	Free	296,644	$44,137	$0.149
1917	do	1,504,871	311,999	.207
1918	do	2,298,476	422,751	.184
1919	do	3,399,026	667,374	.196

[1] In 1914, 588,189 pounds valued at $90,435 were imported, coming principally from Austria-Hungary and Germany.

No exact statistics of exportation or production of other individual American crude drugs are available. Values of "All other roots, herbs, and barks" exported for the years 1909–1918 are given in Table 43. These products in prewar years went chiefly to Germany. Since the war, England has greatly predominated in our export trade, Canada ranking second.

TABLE 41.—*Wholesale prices of ginseng at New York, 1912–1920.*

[Dollars per pound.]

	Cultivated.	Wild northwestern.	Wild southern.	Wild eastern
1912.				
January	6.00	6.00- 6.25	5.50-5.75	6.25-6.
April	6.00	5.50	5.50	6.0
July	6.00-6.50	5.50	4.75- 5.00	6.0
October	6.50-7.50	6.50	5.50- 6.00	7.00-7.25
1913.				
January	5.50-6.00	7.25- 7.50	7.00- 7.25	7.25-7.
April	5.50-6.00	7.25- 8.00	7.00- 7.25	7.25
July	5.00-5.50	6.25- 7.00	6.00- 6.25	6.25
October	5.00-5.50	6.25- 7.00	6.00- 6.25	6.25-7.0
1914.				
January	5.00-5.50	6.25- 7.00	6.00- 6.25	6.25-7.0
April	5.00-5.50	6.25- 7.00	6.00- 6.25	6.25-7.0
July	5.00-5.50	6.25- 7.00	6.00- 6.25	6.25-7.0
October	5.00-5.50	7.25- 7.50	7.00- 7.25	7.00-7.
1915.				
January	5.00-5.50	7.25- 7.50	7.00- 7.25	7.00-7.2
April	5.00-5.50	7.25- 7.50	7.00- 7.25	7.00-7.2
July	5.00-5.50	7.25- 7.50	7.00- 7.25	7.00-7.2
October	5.00-5.50	7.25- 7.50	7.00- 7.25	7.00-7.2
1916.				
January	5.00-5.50	7.25- 7.50	7.00- 7.25	7.00-7.2
April	5.00-5.50	7.24- 7.50	7.00- 7.25	7.00-7.2
July	5.00-5.50	7.25- 7.50	7.00- 7.25	7.00-7.2
October	4.25-5.50	6.50- 6.75	6.25- 6.50	6.25-6.5
1917.				
January	4.25-5.50	6.50- 6.75	6.25- 6.50	6.25-6.5
April	4.25-5.50	6.50- 6.75	6.25- 6.50	6.25-6.5
July	4.25-5.50	6.50- 6.75	6.25- 6.50	6.25-6.5
October	4.25-5.50	6.50- 6.75	6.25- 6.50	6.25-6.5
1918.				
January	4.25-5.50	6.50- 6.75	.....	.....
April	4.25-5.50	6.50- 6.75	6.25- 6.50	6.25-6.5
July	4.50-5.00	.....	6.25- 6.50	.....
October	4.50	.....	.....	.....
1919.				
January	4.50	12.00-15.00	7.50-12.00	.....
April	4.50	.....	.....	.....
July	4.50	.....	.....	.....
October	4.50-6.50	15.00-20.00	12.00-15.00	.....
1920.				
January	4.50-6.50	15.00-20.00	12.00-15.00	.....
April	4.50-6.50	15.00-20.00	12.00-15.00	.....

TABLE 42.—*Domestic exports of ginseng, 1909-1918.*

Exported to—	1909		1910		1911	
	Pounds.	Dollars.	Pounds.	Dollars.	Pounds.	Dollars.
Canada			190	1,403	22	152
China	1,597	10,050	152	827	50	229
Hongkong	184,550	1,259,429	192,002	1,436,761	153,927	1,085,800
Japan			50	378		
Philippine Islands			12	65		
All others	111	700				
Total	186,258	1,270,179	192,406	1,439,434	153,999	1,086,382

Exported to—	1912		1913		1914	
	Pounds.	Dollars.	Pounds.	Dollars.	Pounds.	Dollars.
Canada	66	396	90	675	2,[illegible]	[illegible]
China	30	100	290	1,153	[illegible]	[illegible]
Hongkong	154,749	1,115,964	219,443	1,649,[illegible]	228,[illegible]	1,5[illegible]
Japan	51	300	140	6[illegible]	[illegible]	[illegible]
Philippine Islands	390	2,463	185	7[illegible]	1,[illegible]	4[illegible]
All others	22	78	1,763	13,136	[illegible]	[illegible]
Total	155,308	1,119,301	221,901	1,665,721	234,[illegible]	1,5[illegible]

Exported to—	1915		1916		1917	
	Pounds.	Dollars.	Pounds.	Dollars.	Pounds.	Dollars.
[illegible]nada	1,169	8,490	1,[illegible]	[illegible]	[illegible]	[illegible]
[illegible]na	3,916	33,[illegible]	14,[illegible]	[illegible]	[illegible]	[illegible]
[illegible]ekong	97,596	875,[illegible]	24,[illegible]	1,[illegible]	[illegible]	[illegible]
[illegible]an	503	1,944	[illegible]	[illegible]		[illegible]
[illegible]ippine Islands			[illegible]	[illegible]	[illegible]	[illegible]
[illegible]others			12	[illegible]	[illegible]	[illegible]
Total	103,184	919,931	254,[illegible]	1,[illegible]	[illegible]	[illegible]

Exported to—	1918	
	Pounds.	Dollars.
Canada	[illegible]	[illegible]
China	[illegible]	[illegible]
Hongkong	[illegible]	[illegible]
Japan	[illegible]	[illegible]
Philippine Islands	[illegible]	[illegible]
All others	[illegible]	[illegible]
Total	[illegible]	[illegible]

TABLE 43.—*Domestic exports of all other crude roots, herbs, and barks, 1909–1918.*

Exported to—	1909	1910	1911	1912	1913
Austria-Hungary	$8,707	$9,510	$10,895	$2,528	$3,149
France	24,662	32,520	37,411	38,682	40,957
Germany	176,926	191,864	208,138	197,164	145,039
Italy	18,565	22,094	16,244	11,594	8,974
Netherlands	10,523	18,268	11,796	8,633	14,378
Russia in Europe	7,682	8,458	27,178	30,736	13,527
England	101,154	120,376	183,301	162,966	135,799
Canada	15,520	29,752	36,323	63,100	44,792
Mexico	4,754	6,740	4,227	8,369	3,069
Cuba	759	3,405	1,937	1,525	945
Japan	12,397	18,058	12,456	12,754	2,967
Australia and Tasmania	3,315	1,744	2,029	3,866	2,172
Argentina	915	1,087	717	.....	.....
Brazil	570	148	.....	.....	.....
Chile	925	119	.....	12	7
All others	8,427	12,694	11,210	7,948	8,548
Total	395,801	476,837	563,862	549,877	424,312

Exported to—	1914	1915	1916	1917	1918
Austria-Hungary	$1,725	$1,370	.....	.....	.....
France	44,617	35,447	$115,912	$145,592	$16,92
Germany	201,105	17,445	.....	.....	.....
Italy	15,711	32,136	43,095	38,323	32,45
Netherlands	29,296	7,485	8,787	3,654	.....
Russia in Europe	6,972	7,867	31,041	17,608	8,29
England	109,691	239,601	224,370	280,814	179,79
Canada	58,864	52,150	49,949	93,849	151,99
Mexico	1,674	585	2,599	18,034	16,85
Cuba	2,063	953	7,805	6,634	28,17
Japan	12,996	19,085	45,835	64,036	96,25
Australia	8,577	1,225	17,079	22,625	22,51
Argentina	15,719	10,120	27,983	16,326	23,83
Brazil	.....	530	9,721	10,569	10,15
Chile	77	872	10,531	22,014	26,44
All others	3,984	43,219	174,270	112,178	171,21
Total	513,071	470,090	768,977	852,256	784,51

CASCARA SAGRADA.

Cascara sagrada is the bark of a small tree native to the Pacifi slope. In therapeutic importance it probably ranks first amon American native medicinals. No statistics of production are availabl but the United States Dispensatory has estimated that 3,000,000 t 4,000,000 pounds are annually collected from the uncultivated tree As yet the commercial cultivation of cascara is merely experimenta but the present rate of collection is expected to make serious inroa upon the wild supply within a few years. Cascara is used as a laxa tive and cathartic; its medicinal action is closely allied to that imported rhubarb and senna. Import and export statistics are n shown separately. The wholesale prices of cascara sagrada, which a shown in Table 44, have ranged in recent years from 7 cents to 2 cents per pound.

TABLE 44.—*Wholesale prices of cascara sagrada, New York, 1912–19.*

[Cents per pound.]

1912:		1916:	
January	9 –12½	January	6½– 9
April	9 –10½	April	7½–9
July	9½–10½	July	7½–10
October	8 –10	October	7½–11
1913:		1917:	
January	8 –10	January	8½–11
April	7½– 9	April	9½–11
July	7½–10	July	9½–14
October	7½–10	October	9½–14
1914:		1918:	
January	7½–10	January	12½–15
April	7½–10	April	14 –16
July	7½–10	July	15 –16
October	8 –10½	October	15 –18
1915:		1919:	
January	7½– 9½	January	14½–15
April	7½–10	April	14½–15
July	7½–10	July	14 –15
October	7 – 7½	October	12 –13

GOLDENSEAL OR HYDRASTIS.

The wild goldenseal or hydrastis plant was formerly abundant in the Ohio Valley, but is now becoming rare. Cultivation is practiced to some extent in the United States and has also received some attention in Austria and Italy. Apparently, however, no commercial supplies are yet forthcoming from foreign sources. From 200,000 to 300,000 pounds of the underground stem and roots are said to be collected annually (U. S. Dispensatory). It owes its medicinal value to the alkaloids, hydrastine, and berberine, which are prepared from it. Hydrastis is chiefly used in catarrhal affections of the mucous membrane. Prices of powdered goldenseal root have shown but slight variation since 1912; the lowest price was $4 per pound (quoted in July, 1913, and the highest $6.50 in October, 1916.

OTHER AMERICAN DRUGS.

Wild cherry bark.—This is the bark of the black cherry, a valuable lumber tree. It is extensively collected in the Southern Appalachians, for use in cough mixtures.

White pine bark.—This is the bark of young trees of the white or Weymouth pine, the species chiefly valued for timber. It is used in cough medicines. Both it and wild cherry bark were in unusual demand during the war, especially during the influenza epidemic.

Podophyllum or mandrake.—The underground stem and roots of a small, herbaceous plant, which grows wild in the Central and Eastern States, are commonly known as mandrake. Considerable quantities are used as a cathartic, usually in mixtures with aloes and cascara.

Sanguinaria or bloodroot.—This is a common plant of east swamps, whose underground stem and roots are used in bronch complaints.

Red clover flowers.—The heads of the common red clover are c lected in the southern Appalachians and used in "blood purifier They have, however, no medicinal value. The collection of "clo tops" in the United States has been considerably stimulated by cutting off of the German supplies.

Other native drugs of some commercial importance include lobe senega, pink root, wahoo bark, and slippery elm.

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The Commission has in its files in manuscript form Tariff Inform tion Surveys on the individual drugs discussed in this report. T following are the principal sources from which information has b drawn:

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PROVISIONS IN THE TARIFF ACT OF OCTOBER 3, 1913, FOR DRUGS AND RELATED PRODUCTS.

SCHEDULE A.

1. Acids: Boracic acid, ¾ cent per pound; citric acid, 5 cents per pound; formic acid, 1½ cents per pound; gallic acid, 6 cents per pound; lactic acid, 1½ cents per pound; oxalic acid, 1½ cents per pound; pyrogallic acid, 12 cents per pound; salicylic acid, 2½ cents per pound; tannic acid and tannin, 5 cents per pound; tartaric acid, 3½ cents per pound; all other acids and acid anhydrides not specially provided for in this section, 15 per centum ad valorem.

5. Alkalies, alkaloids, and all chemical and medicinal compounds, preparations, mixtures and salts, and combinations thereof not specially provided for in this section, 15 per centum ad valorem.

8. Argols or crude tartar or wine lees crude or partly refined, containing not more than 90 per centum of potassium bitartrate, 5 per centum ad valorem; containing more than 90 per centum of potassium bitartrate, cream of tartar, and Rochelle salts or tartrate of soda and potassa, 2½ cents per pound; calcium tartrate crude, 5 per centum ad valorem.

9. Balsams: Copaiba, fir or Canada, Peru, tolu, and all other balsams, which are natural and uncompounded and not suitable for the manufacture of perfumery and cosmetics, if in a crude state, not advanced in value or condition by any process or treatment whatever beyond that essential to the proper packing of the balsams and the prevention of decay or deterioration pending manufacture, all the foregoing not specially provided for in this section, 10 per centum ad valorem; if advanced in value or condition by any process or treatment whatever beyond that essential to the proper packing of the balsams and the prevention of decay or deterioration pending manufacture, all the foregoing not specially provided for in this section, 15 per centum ad valorem: *Provided*, That no article containing alcohol shall be classified for duty under this paragraph.

13. Caffein, $1 per pound; compounds of caffein, 25 per centum ad valorem; impure tea, tea waste, tea siftings or sweepings, for manufacturing purposes in bond, pursuant to the provisions of the Act of May sixteenth, nineteen hundred and eight, 1 cent per pound.

14. Calomel, corrosive sublimate, and other mercurial preparations, 15 per centum ad valorem.

15. Chalk, precipitated, suitable for medicinal or toilet purposes; chalk put up in the form of cubes, blocks, sticks, or disks, or otherwise, including tailors', billiard, red, and other manufactures of chalk not specially provided for in this section, 25 per centum ad valorem.

16. Chemical and medicinal compounds and preparations, including mixtures and salts, distilled oils, essential oils, expressed oils, rendered oils, greases, ethers, flavoring and other extracts and fruit essences, all the foregoing and their combinations when containing alcohol, and all articles consisting of vegetable or mineral objects immersed or placed in, or saturated with, alcohol, except perfumery and spirit varnishes, and all alcoholic compounds not specially provided for in this section, if containing 20 per centum of alcohol or less, 10 cents per pound and 20 per centum ad valorem; containing more than 20 per centum and not more than 50 per centum of alcohol, 20 cents per pound and 20 per centum ad valorem; containing more than 50 per centum of alcohol, 40 cents per pound and 20 per centum ad valorem.

17. Chemical and medicinal compounds, combinations and all similar articles dutiable under this section, except soap, whether specially provided for or not, put up in individual packages of two and one-half pounds or less gross weight (except samples without commerial value) shall be dutiable at a rate not less than 20 per centum ad valorem: *Provided*, That chemicals, drugs, medicinal and similar substances, whether dutiable or free, imported in capsules, pills, tablets, lozenges, troches, ampoules, jubes, or similar forms, shall be dutiable at not less than 25 per centum ad valorem.

and all fruit ethers, oils, and essences, and essential and distilled oils and all combinations of the same, not specially provided for in this section, 20 per centum ad valorem: *Provided*, That no article containing alcohol shall be classified for duty under this paragraph.

47. Opium, crude or unmanufactured, and not adulterated, containing 9 per centum and over of morphia, $3 per pound; opium of the same composition, dried to contain 15 per centum or less of moisture, powdered, or otherwise advanced beyond the condition of crude or unmanufactured, $4 per pound; morphia or morphine, sulphate of, and all alkaloids of opium, and salts and esters thereof, $3 per ounce; cocaine, ecgonine, and all salts and derivatives of the same, $2 per ounce; aqueous extract of opium, for medicinal uses, and tincture of, as laudanum, and other liquid preparations of opium, not specially provided for in this section, 60 per centum ad valorem; opium containing less than 9 per centum of morphia, $6 per pound; but preparations of opium deposited in bonded warehouses shall not be removed therefrom without payment of duties, and such duties shall not be refunded: *Provided*, That nothing herein contained shall be so construed as to repeal or in any manner impair or affect the provisions of an act entitled "An act to prohibit the importation and use of opium for other than medicinal purposes," approved February ninth, nineteen hundred and nine.

65. Salts and all other compounds and mixtures of which bismuth, gold, platinum, rhodium, silver, or tin constitute the element of chief value, 10 per centum ad valorem.

70. Vanillin, 10 cents per ounce; vanilla beans, 30 cents per pound; tonka beans, 25 cents per pound.

67. Soda: Benzoate of, 5 cents per pound; chlorate of, and nitrite of, ½ cent per pound; bicarbonate of, or supercarbonate of, or saleratus, and other alkalies containing 50 per centum or more of bicarbonate of soda; hydrate of, or caustic; phosphate of; hyposulphite of; sulphid of, and sulphite of, ¼ cent per pound; chromate and bichromate of, and yellow prussiate of, ¾ cent per pound; borate of, or borax refined; crystal carbonate of, monohydrate, and sesquicarbonate of; sal soda, and soda crystals, ⅛ cent per pound; and sulphate of soda crystallized, or Glauber salts, $1 per ton.

SCHEDULE C.

144. Antimony, as regulus or metal, and matte containing antimony but not containing more than 10 per centum of lead, 10 per centum ad valorem; antimony oxide, salts, and compounds of, 25 per centum ad valorem.

SCHEDULE G.

233. Dandelion root, and acorns prepared, and articles used as coffee, or as substitutes for coffee, not specially provided for in this section, 2 cents per pound.

235. Spices, unground: Cassia buds, cassia, and cassia vera; cinnamon and cinnamon chips; ginger root, unground and not preserved or candied; nutmegs; pepper, black or white; capsicum or red pepper, or cayenne pepper; and clove stems, 1 cent per pound; cloves, 2 cents per pound; pimento, ¼ of 1 cent per pound; sage, ½ cent per pound; mace, 8 cents per pound; Bombay or wild mace, 18 cents per pound; ground spices, in each case, the specific duty per pound enumerated in the foregoing part of this paragraph for unground spices, and in addition thereto a duty of 20 per centum ad valorem; mustard, ground or prepared, in bottles or otherwise, 6 cents per pound; all other spices not specially provided for in this section, including all herbs or herb leaves in glass or other small packages for culinary use, 20 per centum ad valorem.

SCHEDULE H.

249. All mineral waters and all imitations of natural mineral waters, and all artificial mineral waters not specially provided for in this section, in bottles or jugs containing not more than one-half pint, 10 cents per dozen bottles; if containing more than one-half pint and not more than one pint, 15 cents per dozen bottles; if containing more than one pint and not more than one quart, 20 cents per dozen bottles; if imported in bottles or in jugs containing more than one quart, 18 cents per gallon; if imported otherwise than in bottles or jugs, 8 cents per gallon; and in addition thereto, on all of the foregoing, duty shall be collected upon the bottles or other containers at one-third of the rates that would be charged thereon if imported empty or separately.

FREE LIST.

398. Aconite.

400. Antitoxins, vaccine virus, and all other serums derived from animals and used for therapeutic purposes.

402. Arrowroot in its natural state and not manufactured.
405. Asafetida.
409. Balm of Gilead.
410. Barks, cinchona or other, from which quinine may be extracted.
421. Blue vitriol, or sulphate of copper; acetate and subacetate of copper or verdigris.
442. Castor or castoreum.
454. Cocculus indicus.
473. Dandelion roots, raw, dried or undried, but unground.
515. Iodine, crude, or resublimed.
516. Ipecac.
519. Jalap.
541. Manna.
544. Marshmallow or althea root, leaves, or flowers, natural or unmanufactured.
558. Nux vomica.
561. Oils: Birch tar, cajeput, coconut, cod, cod-liver, cottonseed, croton, ichthyol, juglandium, palm, palm-kernel, perilla, soya-bean, and olive oil rendered unfit for use as food or for any but mechanical or manufacturing purposes, by such means as shall be satisfactory to the Secretary of the Treasury and under regulations to be prescribed by him; Chinese nut oil, nut oil or oil of nuts not specially provided for in this section; petroleum, crude or refined, and all products obtained from petroleum, including kerosene, benzine, naphtha, gasoline, paraffin, and paraffin oil; and also spermaceti, whale, and other fish oils of American fisheries, and all fish and other products of such fisheries.
584. Quinia, sulphate of, and all alkaloids or salts of cinchona bark.
585. Radium and salts of, radioactive substitutes, selenium and salts of.
591. Salicin.
592. Salep, or salop.
594. Santonin, and its combinations with acids not subject to duty under this section.
595. Seeds: Cardamom, cauliflower, celery, coriander, cotton, cummin, fennel, fenugreek, hemp, hoarhound, mangelwurzel, mustard, rape, Saint John's bread or bean, sorghum, sugar beet, and sugar cane for seed; bulbs and bulbous roots; not edible and not otherwise provided for in this section; all flower and grass seeds; coniferous evergreen seedlings; all the foregoing not specially provided for in this section.
616. Strychnia or strychnine, and its combinations with acids not subject to duty under this section.
617. Sulphur in any form, brimstone, and sulphur ore as pyrites, or sulphuret of iron in its natural state, containing in excess of 25 per centum of sulphur.
635. Turpentine, Venice, and spirits of.

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UNITED STATES TARIFF COMMISSION
WASHINGTON

Tariff Information Series—No. 20

Agricultural Staples and the Tariff

Production, Trade, and Foreign Competition, with Special Reference to Canada

Wheat and wheat flour
Oats and oatmeal
Barley and barley malt
Flaxseed and linseed oil
Potatoes
Hay

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FOREWORD.

This report is one of a series which the United States Tariff Commission is publishing as an aid to the study and clearer understanding of the tariff and its bearing on various industries. In the present instance, a study has been made of production, trade, and foreign competition in six of the principal agricultural staples, with particular reference to the tariff. Especial attention is given to a comparison of conditions in Canada and in the United States.

The body of the report consists of an introduction and six commodity studies, each prefaced by a summary and a statement of conclusions.

In the preparation of this report the Commission had the services of L. B. Zapoleon, of the Commission's staff, George E. Putnam, and others.

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INTRODUCTION.

Purpose and scope of the report.—The primary purpose of the present study is to ascertain, so far as possible, the effects of the American import duties on the principal agricultural staples. Six major crops—wheat, oats, barley, flaxseed, hay, and potatoes—were selected with this design. That their tariff problems are important is indicated by the fact that in the agricultural census of 1909 they occupied about 53 per cent of the area and constituted about 40 per cent of the aggregate value of all field crops. With the inclusion of cotton and corn, 94 per cent of the cultivated area would be represented. But foreign competition in corn and cotton is unimportant, the United States producing much more than the rest of the world combined.

In order to simplify the fulfillment of the purpose in view, chief attention will be given to production, trade, and prices in the United States and Canada during the past decade. Canada is chosen in this connection because of her propinquity and because of her large and growing surplus, an increasing proportion of which is finding its way to American markets. She is the nation from which most of our imports of the six selected products might be expected to come in the absence of restraining duties, for these products constitute fully 95 per cent of her area in field crops.

Comparison of the United States and Canada as agricultural nations.—In racial characteristics, standards of living, and agricultural methods no other nation so closely resembles the United States as does Canada. In both countries natural forces have operated to determine in advance the character of agricultural methods. Owing to the abundance of free and fertile land, the average size of farms has been large, extensive methods of cultivation have been the rule, and soil-depleting crops have been the most profitable. The migration of the older settlers from the less productive lands of the East to the newer and more productive lands of the West has been a prominent characteristic of the agricultural economy of both countries, leaving in its wake abandoned farms and agricultural maladjustment.

Moreover, the large supply of free and fertile land has been instrumental in causing a farm-labor problem no less serious in the one nation than in the other. Both north and south of the border farm laborers, working for hire, have been scarce, not because there were few agricultural workers, but because there were few who cared to work in the employ of another when it was possible to gain economic independence by becoming landowners. Thus the free and easy path to landownership, under the liberal land policies of the

two Governments, has made farm wages high; higher in Alberta than in Ontario, just as they have been higher in Montana than in New York State. In order to cope with the problem of paying high wages to farm laborers and at the same time make a profit from their operations, Canadian and American farmers have adopted similar expedients—they have resorted to the use of labor-saving machinery where possible, or to the production of those crops which tended to economize in labor, however much the labor economy may have caused the waste of land.

The American supply of unoccupied lands readily available for cultivation has been nearly exhausted. It is only through large capital expenditures for irrigation, drainage, and clearing of "cut-over" lands that the area in farms may now be greatly expanded. In Canada, on the other hand, there are still millions of acres open to settlement and cultivation. Moreover, her physical and economic limitations greatly restrict the choice of crops which can profitably be grown, while south of the border a more diversified agriculture prevails. The rapid decline of American exports of such breadstuffs and meats as constitute the great bulk of the Canadian surplus, and the growing imports of farm produce, were a significant feature of the prewar trade.

Comparison of natural advantages.—The fact remains, however, that the difference in climate between Canada and the United States has given rise to important differences in both the kind and the quality of their agricultural products. The climate of Canada has given her a natural advantage over the greater part of the United States in the production of some varieties of wheat, oats, barley, hay, and in flaxseed and potatoes. These crops require cool weather for proper development. Although they are grown to advantage in many parts of this country in competition with other products, the yield on the whole is lighter, and the quality of the cereals is generally inferior to that of the Canadian product. In the production of these staples, it is clearly a climatic advantage which the Canadian farmer enjoys, inasmuch as climate seems to be of as much practical importance as seed or soil. In the western Provinces, he has the further advantage of a virgin soil. On the other hand, such products as cotton, tobacco, corn, and many kinds of fruits, nuts, and vegetables are ill-adapted to the low temperature and short growing season of Canada. In southern Ontario, where the climate is not very different from that of New York State or Michigan, some corn is grown "for husking." In other Provinces, corn, if grown at all, is generally grown "for fodder," as the seasons are too short and cool to permit the grain to ripen.

Agricultural trade between Canada and the United States.—The degree of interdependence between Canada and the United States in

agricultural produce as the result of climatic differences is shown in the table below. It will be seen that the great bulk of the American exports of vegetable produce to Canada consists of noncompetitive commodities—that is, commodities produced in the Dominion to only a small extent, or not at all; such as cotton, corn and corn meal, fruits (raisins, lemons, oranges, prunes), nuts (chiefly peanuts), unmanufactured tobacco, sugar, and molasses. Nearly all of the exports from Canada, on the other hand, are competitive, particularly with products of the Northern States; the chief items being wheat and wheat flour, oats, flaxseed, hay, potatoes, and live stock.

Reference to the first column, giving for the eight fiscal years, 1912–1919, the total of agricultural products exported to and imported from Canada, will show an approximate net balance of $77,882,930 in favor of the United States.

Agricultural products:		
Exports to Canada		$845,082,655
Imports from Canada		627,064,828
Balance in favor of the United States		217,967,827
Deduct from this balance in favor of the United States the following American nominal exports to Canada, which were for the most part reexported:		
Wheat and wheat flour	$110,213,112	
Oats	29,871,985	
		140,085,097
Approximate net balance		77,882,730

Agricultural trade between the United States and Canada.

[Compiled from Commerce and Navigation of the United States.]

	Total, 8 years, 1912–1919.		1912		1918	
	Exports to Canada.	Imports from Canada.	Exports to Canada.	Imports from Canada.	Exports to Canada.	Imports from Canada.
VEGETABLE PRODUCTS.						
Breadstuffs:						
Corn and corn meal	$70,562,936	$215,713	$6,738,600	$12,824	$4,946,692	$3,222
Oats	[1] 29,871,985	12,597,588	50,093	1,042,129	587,105	275,550
Wheat and wheat flour	[1] 110,213,112	123,467,341	908,227	2,848,443	1,279,515	976,898
All other	12,139,105	27,952,738	554,416	2,967,903	910,402	1,492,630
Broom corn	3,964,679	1,031	287,931	40	295,174	.....
Coal	124,035,150	27,804	9,202,089	21,387	8,989,591	203
Flaxseed	151,050	76,806,116	11,263	6,608,312	119	7,187,547
Fruits	97,641,485	1,798,493	8,431,078	177,287	8,955,203	186,390
Hay	5,566,086	701,391	341,220	6,177	396,942	13,058
Hops	1,926,355	19,346,517	285,051	6,469,862	469,348	1,500,641
Live stock	1,934,201	1,292	509,404	474	244,098	.....
Nursery products	2,489,741	84,991	311,828	9,916	422,065	11,302
Nuts	12,697,488	8,799,090	716,434	798,113	1,101,289	465,623
Starch	707,821	275,250	63,051	8	61,244	5
Sugar and molasses	7,163,496	3,425,994	190,029	289,785	212,053	119,818
Tobacco, unmanufactured	33,090,007	1,284,463	2,335,466	114,518	2,709,030	108,850
Vegetables:						
Potatoes	3,799,605	9,538,393	339,818	128,076	333,455	42,666
All other	20,120,295	10,309,746	2,152,633	882,630	2,476,556	371,407
Yeast	3,298,254	.....	151,068	.....	245,569	.....
All other vegetable products	40,191,101	45,090,271	1,863,122	3,580,890	2,316,689	5,477,826
	563,952	341,290,427	35,538,431	25,958,774	30,942,019	18,233,661

[1] Reexported from Canada.

Agricultural trade between the United States and Canada—Continued.

	Total 8 years, 1912–1919.		1912		1913	
	Exports to Canada.	Imports from Canada.	Exports to Canada.	Imports from Canada.	Exports to Canada.	Imports from Canada.
ANIMAL PRODUCTS.						
Eggs and egg products	16,749,300	1,999,932	1,944,078	15,078	2,770,126	17,037
Dairy products	8,230,180	20,581,112	614,352	1,056,678	413,045	1,166,539
Furs and fur skins, raw	15,955,906	39,391,745	2,260,475	2,267,807	2,767,546	2,197,509
Live stock	44,682,811	103,687,746	4,894,999	600,838	4,726,315	1,549,501
Packing-house products:						
Hides and skins	20,119,602	63,212,555	1,857,279	5,308,203	2,085,578	7,613,219
Meats	109,344,806	21,239,981	3,147,965	(1)	4,140,125	(1)
Oils	2,138,394	280,279	42,550	.....	51,920	.....
All other	19,734,971	6,078,482	1,242,908	208,964	1,905,579	242,662
Poultry and game	752,259	(1)	135,047	(1)	243,391	(1)
Wool, raw	5,288,964	21,072,355	.....	151,588	.....	63,156
All other animal products	12,031,511	8,232,216	1,340,700	759,075	1,535,806	953,747
Total animal products	254,978,704	285,774,401	17,480,353	10,368,231	20,639,430	13,803,391
Total agricultural products	845,082,655	627,064,828	53,018,784	36,326,005	57,581,449	32,037,052
Excess of exports	217,968,827	.....	16,692,779	.....	25,544,397	.....
Excess of imports	.....	.....	.....	.....	.....	.....

	1914		1915		1916	
	Exports to Canada.	Imports from Canada.	Exports to Canada.	Imports from Canada.	Exports to Canada.	Imports from Canada.
VEGETABLE PRODUCTS.						
Breadstuffs:						
Corn and corn meal	$3,557,921	$13,552	$6,401,686	$115,246	$5,203,095	$12,814
Oats	8,792	7,879,891	1,430,763	272,318	1,072,101	275,346
Wheat and wheat flour	4,371,661	2,038,970	20,533,399	722,513	7,685,541	7,452,644
All other	786,067	2,497,594	1,041,667	1,615,603	885,875	3,154,153
Broom corn	259,104	820	280,688	170	343,604	.....
Cotton	11,027,923	.....	7,706,548	77	11,680,461	4,297
Flaxseed	.....	10,561,662	2,444	8,843,489	288	5,135,164
Fruits	10,107,603	219,950	9,209,177	219,371	10,376,393	200,318
Nuts	468,986	17,060	345,029	1,962	529,906	13,481
Hay	249,832	1,616,859	191,599	220,084	189,809	674,536
Hops	289,469	303	192,759	1	95,259	.....
Nursery products	343,131	21,376	185,748	3,088	205,177	10,530
Seeds	1,277,272	957,397	1,964,902	316,995	2,183,924	310,911
Starch	63,265	39	50,959	34	70,928	52
Sugar and molasses	149,327	199,208	189,212	146,536	284,569	204,549
Tobacco, unmanufactured	2,953,817	81,272	2,658,563	101,818	3,214,216	56,110
Vegetables:						
Potatoes	297,002	459,782	381,777	27,863	160,247	16,370
All other	2,378,451	687,841	1,946,393	998,914	3,316,551	808,264
Yeast	272,736	.....	194,195	.....	370,706	.....
All other vegetable products	2,379,836	3,038,383	2,241,234	5,264,061	4,064,022	3,012,032
Total vegetable products.	41,242,195	30,291,909	57,148,742	18,860,143	51,932,672	21,341,573
ANIMAL PRODUCTS.						
Eggs and egg products	2,240,370	87,685	1,411,987	169,231	1,745,675	58,700
Dairy products	310,941	2,341,093	1,124,738	3,270,392	997,823	1,635,645
Furs and fur skins, raw	1,023,610	1,981,637	818,829	1,762,269	1,673,539	4,183,962
Live stock	3,612,544	11,095,246	6,345,741	12,678,838	12,050,369	12,663,572
Packing-house products:						
Hides and skins	1,458,937	8,956,648	3,813,157	7,505,918	3,053,309	6,979,975
Meats	4,862,661	2,131,589	3,126,547	4,728,522	12,561,571	1,313,335
Oils	87,168	.....	76,064	.....	58,037	.....
All other	2,181,703	595,930	1,493,098	970,294	1,192,243	503,436
Poultry and game	165,809	(1)	33,391	(1)	41,152	(1)
Wool, raw	7	1,110,324	573,329	1,723,924	2,283,971	1,991,903
All other animal products	999,547	2,051,434	1,007,188	671,884	1,429,146	821,207
Total animal products	16,933,297	30,351,586	19,824,069	33,481,272	37,036,835	30,151,735
Total agricultural products	58,175,491	60,643,495	76,972,811	52,341,415	88,969,507	51,493,308
Excess of exports	.....	.....	24,631,396	.....	37,476,199	.....
Excess of imports	.....	2,468,004	.....	.....	.....	.....

[1] Not separately stated.

[2] Included in "all other."

Agricultural trade between the United States and Canada—Continued.

	1917		1918		1919 [4]	
	Exports to Canada.	Imports from Canada.	Exports to Canada.	Imports from Canada.	Exports to Canada.	Imports from Canada.
VEGETABLE PRODUCTS.						
Breadstuffs:						
Corn and corn meal	$16, 80	$12,281	$13,756,128	115	$13,516,234	[illegible]
Oats	29	470,877	3,323,401	1 173	22,959,807	441,004
Wheat and wheat flour	10, 55	42,829,972	1,462,007	56 168	63,535,907	9,913,333
All other	8, 26	3,417,411	2,073,956	7 333	2,875,786	4,932,611
Broom corn	60	.....	1,018,111	1	880,907	.....
Cotton	16, 04	3	31,205,703	115	28,716,131	23
Flaxseed	18	17,834,606	31,200	16 922	104,318	4,759,714
Fruits	13, 63	196,509	18,071,277	145	19,154,691	283,723
Nuts	1, 19	15,592	1,505,376	92	931,798	437,874
Hay	65	634,230	80,467	4 331	287,084	3,057,672
Hops	14	494	164,867	6	816,731	14
Nursery products	60	12,357	339,731	142	413,201	12,070
Seeds	1, 97	1,005,431	1,902,321	2 178	1,963,169	2,099,142
Starch	51	61,049	190,989	173	84,634	104,390
Sugar and molasses	59	437,872	1,344,796	120	4,416,051	1,110,906
Tobacco, unmanufactured	3, 84	187,633	6,296,212	336	9,459,019	405,676
Vegetables:						
Potatoes	610,648	4,153,539	903,308	1,077,144	773,350	3,032,928
All other	6,433,330	2,256,609	6,245,020	1,701,429	4,168,361	2,602,562
Yeast	201,866	.....	640,211	.....	1,031,902	.....
All other vegetable products	7,167,138	6,351,884	10,778,212	6,868,423	9,280,848	11,506,822
Total vegetable products	82,168,660	79,349,049	100,336,108	101,028,596	184,750,130	46,227,722
ANIMAL PRODUCTS.						
Eggs and egg products	3,226,397	162,257	1,959,732	206,025	1,350,986	1,193,919
Dairy products	1,945,991	1,917,757	1,251,507	3,867,433	1,571,783	5,225,584
Furs and fur skins, raw	1,855,874	5,264,287	2,099,925	8,269,943	3,456,106	13,464,281
Live stock	6,126,186	10,260,135	4,006,245	17,313,118	2,911,412	37,526,496
Packing-house products:						
Hides and skins	2,104,699	7,576,619	3,307,976	8,463,925	2,438,665	10,908,043
Meats	38,156,575	1,400,554	28,109,460	3,557,897	17,229,902	8,007,794
Oils	213,339	.....	1,147,407	.....	461,909	280,279
All other	2,769,254	577,540	3,053,377	972,507	5,896,909	2,007,049
Poultry and game	73,097	(3)	23,861	(3)	36,511	(3)
Wool, raw	1,225,071	4,075,397	890,691	6,516,892	315,595	5,439,141
All other animal products	1,927,563	1,084,292	2,036,912	895,606	1,764,649	1,041,971
Total animal products	57,734,046	32,269,088	47,896,095	50,256,436	37,444,579	85,092,662
Total agricultural products	139,897,708	111,617,137	148,232,198	151,285,032	222,194,709	131,320,384
Excess of exports	28,280,569	.....	.....	.....	90,874,325	.....
Excess of imports	.....	.....	.....	3,052,834	.....	.....

[3] Included in "all other." [4] Preliminary figures.

WHEAT AND WHEAT FLOUR.

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Note.—No direct consideration has been given the complex situation which has developed in the wheat and flour trade since this report was sent to the Government Printing Office on June 28, 1920. Factors herein indicated to be inherent or potential have come into active operation; and the developments are so wide in scope and so serious in character that careful and intensive investigation is necessary before their significance can be discussed. In view of the fact that their broad general tendencies have been outlined, it has been thought best to let this report go out as originally prepared, and to present at a later date the results of the tendencies now in operation.

During the four months July to October, 1920, inclusive, imports of wheat amounted to 12,109,217 bushels, valued at $28,146,296; and of flour to 222,002 barrels, valued at $2,535,182. Substantially all of these shipments came from Canada, and were shipped during the latter part of September and in October. During the same four months exports of wheat from the United States amounted to 117,981,296 bushels, or $339,278,529, and of flour to 6,055,829 barrels, valued at $70,114,803.

WHEAT AND WHEAT FLOUR.

SUMMARY AND CONCLUSIONS.

In the tariff act now in force—that of October 3, 1913—reciprocal free trade is offered in wheat and wheat flour. The principal exporting nations that are likely to ship to this country (Canada, Argentina, and Australia) have removed their customs duties upon American wheat and flour; in consequence their product enters this country duty free and in growing volume. Except for relatively small exports to Canada, no American wheat or flour is shipped to these countries.

The wheat consumption of the United States is much greater than that of any other country. Its potential production likewise is far in excess of domestic requirements. But whether wheat or alternative farm products are raised is largely a matter of price and comparative advantage. It is on relatively low-priced land, in sparsely populated regions far distant from the ultimate markets, that much of the world's crop is ordinarily grown.

The great increase in the American production, during the 30 years preceding the World War, had been primarily due to the new lands that were brought under cultivation. It coincided with a diminishing proportion of older arable lands sown to wheat, even in the grain belt. In the older regions wheat culture had lost ground because of the competition of other crops and of more productive and cheaper land elsewhere available. From such unoccupied areas as may hereafter be cultivated no large contribution is to be anticipated. Moreover, the increase in production has not kept pace with the growth of population and consumption. Most of the States now consume more wheat than they produce.

In the years immediately preceding the World War American exports of wheat, in the grain, had come to consist largely of the exports of the Pacific Northwest, which ordinarily can ship more cheaply to the Orient and to Europe than to the distant American consuming markets, and of durum wheat, for which there was then only a small domestic demand. Only in the last two of the nine fiscal years, 1906–1914, did exports of Pacific and durum wheat constitute less than 40 per cent of the total wheat shipments. Of the remaining Atlantic and Gulf exports, a considerable proportion probably consisted of the lower grades of hard and soft wheat, which are ordinarily not desired by American millers.

Flour constituted an increasing proportion of the exports, and flour shipments consisted in large part of "clears" and low grades, for which there is only a relatively small domestic market. Of combined wheat and flour, exports had declined from between 30 and 40 per cent of the crop during 1891–1902 to between 10 and 20 per cent during 1902–1914.

Since 1914, however, the United States has been the dominating factor in the world's wheat and flour trade. For an indefinite period the World War has eliminated the surplus of Russia, formerly the largest exporter, and of Roumania. The shipping situation also placed a premium upon North American supplies, and the farmer was guaranteed a minimum price over twice as high as the prewar level. In consequence, wheat cultivation has been maintained and increased in the American regions producing at higher costs. But it is significant that in the crop year 1919–20 a reduction of 20,000,000 acres occurred in the area sown to wheat.

Imports, on the other hand, though still far less than exports, are increasing in volume. Canadian shipments, which constitute the great bulk of the importations, ranged from 1,000,000 to 3,000,000 bushels during the years 1910–1914; in each of the years 1917 and 1918 they amounted to nearly 25,000,000 bushels, valued at $40,000,000 to $50,000,000. In 1919 and 1920 they fell to 4,750,000 and 4,000,000 bushels, respectively. From 1917 on, likewise, substantial importations, free of duty, were made from Argentina and Australia. The receipts during the fiscal years 1918, 1919, and 1920 were arranged by the United States Grain Corporation to meet sectional shortages. Equivalent quantities of flour were exported from other sections. Mill feed to the value of around $2,000,000 annually has also been imported during the last three years, almost exclusively from Canada.

The imports of the past have supplemented the domestic crop, rather than competed with it.[1] In part, they have been due to local or general shortages of the different kinds of wheat, or of the better grades, either for milling or for seed. The demand is not for wheat in general, but for specific classes and qualities to meet particular uses. Imports from Canada consist almost exclusively of hard spring wheat from the western Provinces; from Argentina, of hard and semihard wheats; and from Australia, of soft wheat.

Again, American flour is generally sold under brand; it has an established domestic and foreign trade as opposed to the general and fluctuating demand for wheat. In some foreign markets, also, it enjoys preferential tariff treatment. Such influences promote the importation of foreign wheat for reexport in the form of flour, especially as there is an enormous domestic market for the milling by-products.

[1] That is, until August 30, 1920. See Note, p. 13.

More important, as a cause of imports, is the geographical situation. The entire region east of the Mississippi, and the southern tier of Western States from Texas to California, is a deficiency section; it is dependent upon 12 of the remaining Western States for about 200,000,000 bushels of its wheat requirements. But these surplus-producing trans-Mississippi States are over a thousand miles from the principal deficiency markets along the Atlantic and Gulf coasts, and in California.

Prewar ocean freights from Argentina to Atlantic and Gulf markets were about half the rail rates from Kansas City and Minneapolis. Ocean freights from Australia to California, likewise, were no higher than the rail rates from the surplus-producing sections of the Pacific Northwest. Although ocean freights since 1914 have greatly exceeded rail rates from the interior, they have been declining. Rail rates have more than doubled. Of greater moment is the pressure of Canadian wheat on the north, for Europe is the chief market for the Argentine and Australian surpluses. Because of the transportation situation, the bulk of the Dominion's growing exports is shipped in bond through the North Atlantic consuming markets; the removal of the American tariff barriers renders this surplus available for domestic consumption.

In Canada, both production and exports have been rapidly increasing, and there are still large areas available for settlement and cultivation. Between 1915 and 1920 Canada's exports of wheat and flour ranged between 80,000,000 and 223,000,000 bushels, valued at $100,000,000 to $450,000,000. On account of the favorable climate of the western Provinces for the production of hard spring wheat, and of the abundance of fresh fertile land (available at much lower prices than wheat lands south of the border) the cost of production is less than in the United States, and the quality of her spring wheat is better on the whole than the quality of the American spring.

The cost of production is likely to remain lower in Canada, for although the superiority of Canadian land may eventually disappear, there will still remain a favorable climate for the growing of hard spring wheat. Moreover, Canada's climate, distance from markets, and sparse population greatly restrict the choice of other crops that may profitably be raised.

While the great increase in Canadian production has occurred in the western Provinces, it is possible that the removal of the tariff barriers may also stimulate production in the soft-wheat producing sections of eastern Canada. Rail rates from these sections to the great consuming markets in the North Atlantic States are considerably lower than from domestic regions of surplus production.

There is a small countercurrent of American soft wheat and flour to western Canada, either for blending purposes or for the manufacture of biscuits and pastry.

An important phase of the traffic between the two countries has been the competition of railroads, lake vessels, primary and export markets for the grain trade. Barred until recently by prohibitive import duties from making large shipments to the great consuming markets south of the border, Canada has embarked upon extensive transportation and shipping projects designed in part to keep her export grain moving via all-Canadian routes, and her facilities have attracted a considerable transit trade of American grain. But the countercurrent of Canadian grain has been far larger. American ports have shipped most of the Dominion's wheat exports, because of their superior shipping facilities, the closed winter season of navigation in the North, and because Canada could not take care of the peak movement during the autumn and spring, before the close of navigation and after its reopening. American lake vessels also carry much of the Canadian grain.

The natural route for Canada's grain surplus is southward and eastward, for concentration, milling, consumption, or export. This is due to a number of factors; the transportation situation; a wheat consumption only about one-tenth as large as in the United States; the dimensions and efficiency of the American milling industry; the wider domestic and foreign markets for American flour and its by-products; the fact that Canada's grain is otherwise thrown on the world's market at the most unfavorable season; and to the heavy return movement of eastern products. The import duties have prevented a larger American participation in the carrying and distribution of Canadian grain, except with respect to the in-bond movement. If the mills had had free access to the hard spring wheat of western Canada, a larger import trade would probably have developed. The export flour trade, likewise, might have been increased.

Both Canadian and American wheat prices have in general reflected quotations in the world markets. But while Winnipeg prices of hard spring wheat were always on an export basis, Minneapolis prices were frequently above the export point. Moreover, Minneapolis prices were consistently higher, though the spread diminished after the reduction and subsequent removal of the duty on Canada's wheat. The differential in favor of Minneapolis was particularly large in years when the harvest of American hard spring wheats was short or of poor quality. This price disparity is especially noteworthy in view of the fact that during 1906–1916 the Canadian wheat was worth several cents more per bushel because of differences in grading.

When the higher price levels in Minneapolis are considered in connection with the equality in freight rates from producing sections in western Canada to Minneapolis, Fort William, Port Arthur, and Duluth, and with the further fact that the costs of transportation from Fort William or Port Arthur to Liverpool via Montreal are, if different at all, slightly lower than from comparable points south of the border, it is evident that the import duties have prevented the equalization of prices in American and Canadian markets through a flow of Canadian grain to the former.[1] Thus, the import duties have been of especial benefit to the American grower in the years of shortage of hard wheat, when domestic prices rose above the export point. The domestic supply of hard spring wheats is grown chiefly in the Dakotas and Minnesota; of hard winter, in Kansas, Nebraska, and Oklahoma. These two classes—hard spring and hard winter—are directly competitive. To a lesser degree, also, they compete with soft wheats. In durum wheat, raised chiefly in the Dakotas and Montana, there is virtually no competition.

East of the Mississippi the crop consists almost entirely of soft wheats. This class is also extensively produced in the trans-Mississippi regions. With respect to soft wheats, it may be noted: (1) That the import duties doubtless have contributed to the decline of soft-wheat production in eastern Canada, which can produce at least as cheaply as can domestic regions of surplus production, and which has besides the advantage in rail rates to New England and north Atlantic markets; (2) that a larger importation of Canadian hard spring wheats may result in an invasion by northern millers of the hard and soft winter wheat markets in the South; and (3) that the regions of deficient production east of the Mississippi have the protection of freight rates from the surplus-producing sections.

The Pacific States are little affected by Canadian competition. Ordinarily they ship their surplus to Europe and the Orient. In fact, free trade with Canada provides an additional though small market for their soft wheat and flour. In return, some hard spring wheat may be imported for blending purposes.

Some authorities maintain that the American farmer would likewise benefit by free trade with Canada. Roughly, at least, prices in both countries reflect Liverpool prices less costs of transportation. The storage and consuming capacity of Liverpool and other European markets has rather definite limitations; moreover, wheat harvests are in progress every month of the year, giving promise of further large supplies. For these reasons a flood of Canadian wheat

[1] It is true that Minneapolis is a great cash market, while Winnipeg is essentially a future market, and that cash or "spot" prices are frequently higher than "to-arrive" quotations, but such price differences are seldom great or long sustained.

in the fall and spring is likely to cause severe price depressions, which in turn would adversely affect American price levels. Once this lower level is established it would be more difficult to advance later. If the Canadian wheat were allowed access to the large markets south of the border, with their great absorbing capacity and large volume of hedging operations, it would be more easily absorbed, and, it is asserted, less likely to depress American prices through pressure upon the final markets. This consideration, however, presupposes a considerable American surplus. It would not apply in case of a domestic shortage, in which event the tariff barrier obviously would advance domestic prices.

In conclusion, a larger volume of supplemental imports, especially from Canada, is to be anticipated. Geographic factors, local or general shortages of different kinds of wheat, and the character of the milling demand—such forces draw foreign supplies for domestic consumption even when large exports of American wheat and flour are moving forward. As yet they are potential rather than actual causes of foreign competition. Whether free trade will result in large imports, how soon or how severe this competition, depends largely upon unstable factors in the international demand and supply. In the chief importing countries national control still prevails. Not only do their policies include national buying, bread subsidies, fixed prices below the world level, and the purchase of wheat rather than of flour, but also the stimulation of production and reduction of imports. In wheat, however, constant national self-sufficiency can not be assured, for climate is much more important than variations in acreage. And in case of need the acreage may be readily increased, though of course largely at the expense of other farm products. In opposition to this attempted curtailment of imports, the surplus of Canada and other exporting countries has been increased, and there is the further possibility of large exports again being made by Russia and Roumania. Doubtless the United States will continue in any event to produce large quantities of wheat (as do the importing countries of Europe)—more extensively in the spring-wheat region, in the dry-farming sections of the West, Southwest, and Pacific Northwest, and largely also in crop rotations elsewhere.

TARIFF PROVISIONS WITH RESPECT TO WHEAT.

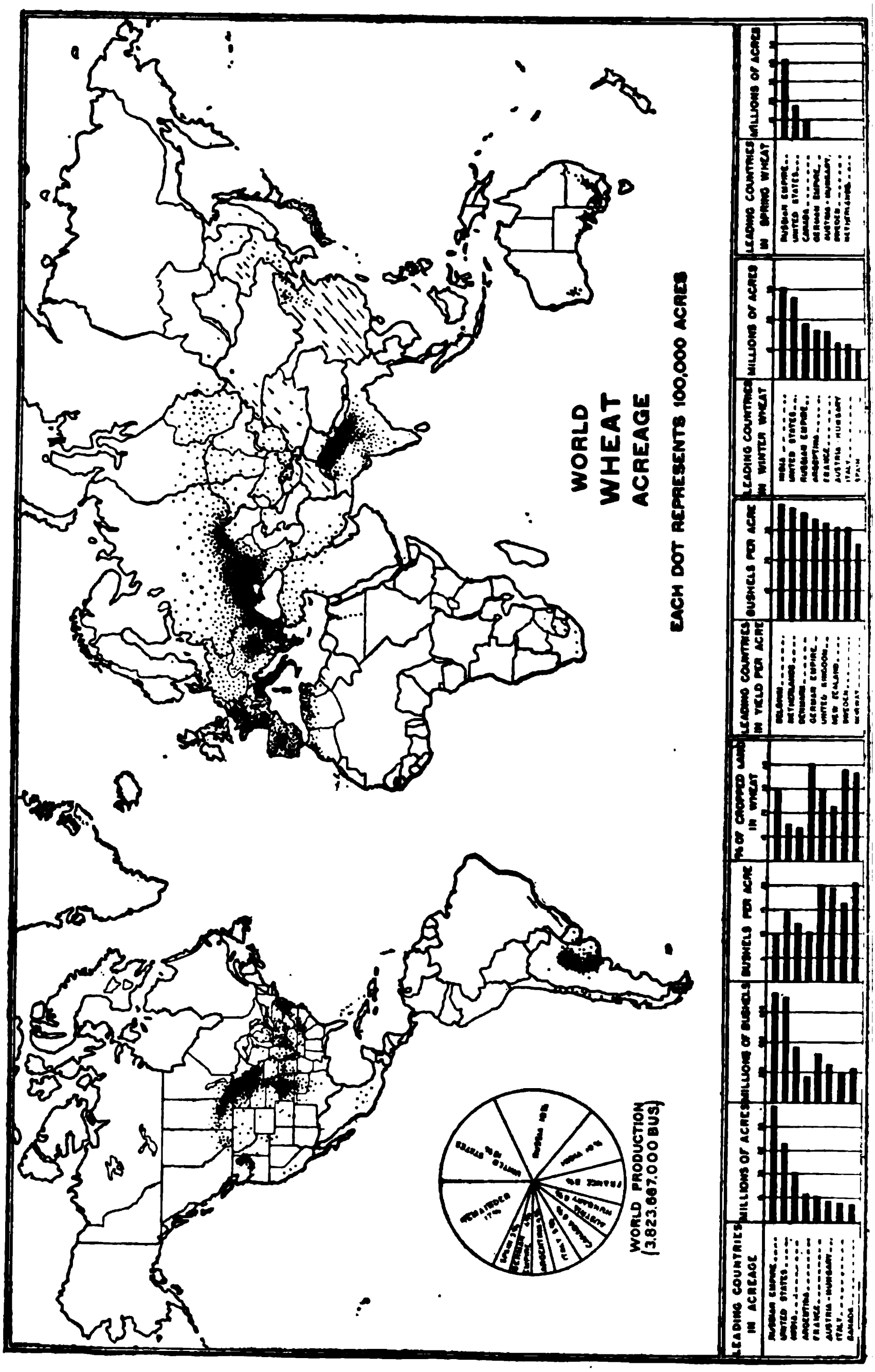
The Underwood Act of 1913 placed wheat—which since 1897 had been subject to a duty of 25 cents a bushel—together with wheat flour, semolina, and other wheat products, on the free list; with the provisions that wheat should be subject to a duty of 10 cents a bushel, wheat flour 45 cents a barrel, and semolina 10 per cent ad valorem when imported from a country which imposed a duty on any or all of these three commodities imported from the United States.

Argentina removed its duty upon these products on December 27, 1913. It was considerably later, and only under the stress of war conditions, when much of the world's shipping moved through American ports, that other important surplus-producing countries accepted the reciprocal free trade in wheat and wheat flour offered through this provision. In order that the Canadian farmer might secure the best price for his wheat, especially in time of war, when urgent appeals were being made for increased production, the Canadian Government directed, by an order in council, under authority of the war measures act of 1914, that on and after April 17, 1917, wheat, wheat flour, and semolina be transferred to the list of goods which might be imported into Canada free of duty. By the amendment of July 7, 1919, to the Canadian customs tariff, wheat and wheat flour were made free of duty when from countries which accorded like treatment to the Canadian product; when from other countries the import duty on wheat was fixed at 12 cents per bushel and on flour at 50 cents per barrel. Australia removed its duty on September 27, 1917, and British India placed wheat temporarily on the free list on January 25, 1919.

Import duties of the United States upon wheat and wheat flour, 1883–1913.

Tariff act. Year.	Tariff act. Paragraph.	Tariff classification or description.	Rate of duty.
1883..	259...	Wheat	20 cents per bushel.
	268...	Wheat flour	20 per cent ad valorem.
1890..	264...	Wheat	25 cents per bushel.
	265...	Wheat flour	25 per cent ad valorem.
1894..	190...	Wheat	20 per cent ad valorem.
		Wheat flour	
1897..	234...	Wheat	25 cents per bushel.
	235...	Wheat flour	25 per cent ad valorem.
1909..	242...	Wheat	25 cents per bushel.
	243...	Wheat flour and semolina	25 per cent ad valorem.
1913..	644...	Wheat, wheat flour, semolina, and other wheat products, not specially provided for in this section: *Provided*, That wheat shall be subject to a duty of 10 cents per bushel, that wheat flour shall be subject to a duty of 45 cents per barrel of 196 pounds, and semolina and other products of wheat, not specially provided for in this section, 10 per centum ad valorem, when imported directly or indirectly from a country, dependency, or other subdivision of government which imposes a duty on wheat or wheat flour or semolina imported from the United States.	Free.

For the present, then, there is free trade in wheat, wheat flour, and semolina between the United States and virtually all important exporting countries which are likely to ship to this country. It is only a nominal free trade, however. On June 1, 1920, the United States relinquished the control it had exercised over imports and exports during its participation in the World War, and also terminated the price guarantee. But in the chief exporting and importing countries national control still prevails. Both production and trade remain of an abnormal character.


WORLD
WHEAT
ACREAGE
EACH DOT REPRESENTS 100,000 ACRES
WORLD PRODUCTION
(3,823,667,000 BUS)
LEADING COUNTRIES IN ACREAGE
MILLIONS OF ACRES
MILLIONS OF BUSHELS
BUSHELS PER ACRE
LEADING COUNTRIES IN SPRING WHEAT
LEADING COUNTRIES IN WINTER WHEAT
LEADING COUNTRIES IN YIELD PER ACRE
% OF CROPPED LAND IN WHEAT

WORLD PRODUCTION AND TRADE.

A brief preliminary review of world production and trade will disclose some phases of the normal competitive situation.

International supply and demand normally regulate the level of domestic prices. Ordinarily American wheat prices are nearly as directly affected by the harvest of Argentina, Canada, or of other large exporting countries as by that of the Dakotas or of Kansas. Of the world production of around 3¾ billion bushels, Europe produces about one-half, the United States 20 per cent, British India 10 per cent, Canada, Argentina, and Australia each around 5 per cent, the remaining 5 per cent being contributed by a large number of countries.[2] Approximately 650,000,000 bushels, or less than one-fifth of the world's annual production, enters into international trade; and this trade consists largely of the imports of about seven industrial nations of Europe, and of the surpluses chiefly of Russia, the United States, Canada, and Argentina, and to a smaller extent of British India, Australia, and Roumania (see table on page 22). The world demand usually remains fairly constant, while the surplus of the exporting nations varies greatly from year to year in both quantity and quality. The dominant influence of the supply factor upon current prices is enhanced by a somewhat distinct demand for different classes and qualities of wheat. Large quantities of soft wheat are grown in the chief importing countries, which are in especial need of the hard varieties for blending in bread flours. Southern Europe also imports much durum wheat for the manufacture of macaroni and other edible pastes.

The principal surplus-producing regions are far distant from markets; population is sparse, the type of agriculture extensive, land relatively cheap, and there is little competition from other crops. Of the total exports, fully 85 per cent moves to western and central Europe. The United Kingdom imports annually over 210,000,000 bushels, or about three times as much as Germany, which usually ranks second among the importing countries. Brazil, with imports of around 20,000,000 bushels, is the most important of the regions of deficient production outside of Europe. Because of the dominant position of the United Kingdom in the import trade, the British market is generally recognized as the "ruling" one. Wheat harvests are constantly in progress in some part of the world, and the exports are seasonal; the volume and quality of the harvests of the principal exporting countries successively affect Liverpool prices and are reflected in other grain centers. In the Northern Hemisphere, the harvests begin about March in British India and end

[2] These figures are based upon averages for the five years 1909–1913. No great or permanent change in the channels of trade as a result of the World War appears probable. Trade statistics include flour, equated to wheat.

in September-October in the more northern latitudes. In the Southern Hemisphere, only the crops of Argentina and Australia, harvested during December and January, are of general interest.

This world trade is in the form of wheat rather than of flour, exports of flour usually constituting only about one-sixth of the total. Higher ocean and rail rates on flour, higher import duties, the local value of mill feed, and local preferences—such factors promote the shipment of the raw material instead of the manufactured product. The United States ships approximately 40 per cent of the world exports of flour, nearly three times as much as Canada, the country ranking second.

TABLE 1.—*International trade in wheat and flour (average, 1909–1913).*

[From the Yearbook of the U. S. Department of Agriculture, 1919.]

EXPORTS.

[In thousands of bushels.]

Country.	Wheat (average, 1909–1913).	Wheat flour (average, 1909–1913).	Wheat and flour (average, 1909–1913).[1]
FROM—	*Bushels.*	*Barrels.*	*Bushels.*
Argentina	89,102	1,365	95,243
Australia	41,997	1,719	49,732
Austria-Hungary	36	193	906
Belgium	19,607	696	22,694
British India	48,781	607	51,510
Bulgaria	8,840	534	11,244
Canada	74,247	3,694	90,871
Chile	2,221	83	2,583
Germany	12,214	1,986	21,149
Netherlands	53,397	222	54,394
Roumania	49,106	725	52,370
Russia	155,752	1,337	161,766
United States	53,316	10,443	100,310
Other countries	16,211	3,154	30,412
Total[2]	624,827	26,748	745,194

IMPORTS.

INTO—			
Belgium	73,826	31	73,967
Brazil	12,283	1,825	20,495
British South Africa	3,425	729	6,708
Denmark	4,068	583	6,711
France	38,172	117	38,698
Germany	88,982	172	89,755
Greece	6,973	13	7,034
Italy	52,775	15	52,866
Japan	2,629	192	3,495
Netherlands	66,896	2,168	76,653
Portugal	3,228	.....	3,228
Spain	4,468	1	4,471
Sweden	6,771	82	7,140
Switzerland	16,558	517	18,885
United Kingdom	192,134	6,005	219,156
Other countries	21,790	11,070	71,574
Total	594,998	23,520	700,836

[1] Flour has been converted into wheat at the rate of 4½ bushels per barrel of flour.

[2] To obtain the net exportable surplus, deductions should be made of the exports of Belgium, Germany, and the Netherlands, which are evidently reexports of foreign wheat.

To the extent that the level of domestic prices is determined, in common with that of other exporting nations, by the situation in the world markets, it would appear that American tariff barriers are of little practical effect. But in point of fact, the great bulk of the United States export trade (in the years immediately preceding the World War) had come to consist of certain types of flour and wheat that do not enter largely into domestic consumption, and of the surplus of the Pacific Northwest. A surplus producing region over 1,000 miles in the interior supplies much of the requirements of the Eastern and Gulf States. Under prewar conditions the large markets in the East and along the Atlantic seaboard could be more cheaply reached by foreign grain. The varying harvest of different classes and varieties results in shortages of specific grades; and the character and channels of the trade in wheat and wheat products are such as to draw foreign supplies.[3] Moreover, the increase in the domestic production has not kept pace with the growth of population and consumption.

THE UNITED STATES AS A FUTURE LARGE IMPORTER OF WHEAT.

Maximum production probably attained.—As a cash crop, wheat is exceeded in value only by cotton; flour milling ranks third among the manufacturing industries (census of 1914), and the enormous production of mill feed is one of the basic factors in the dairy industry. But in most of the States wheat production is already much less than consumption. The area and degree of this deficiency are extending. It is true that since 1914 the harvest of the United States has far exceeded that of any other country. From 1866 to 1913 the domestic area in wheat increased from 15,424,000 to 50,184,000 acres, while the production rose from 152,000,000 to 763,380,000 bushels. During the last 16 years of this period (1898 to 1913) the acreage in wheat fluctuated between 45,000,000 and 50,000,000 acres, although over 70,000,000 acres were added to the improved land.

Changes effected by the World War.—For the subsequent increase in acreage the war has been the chief cause. It has eliminated for an indefinite period the surplus of Russia, formerly the largest exporter, and of Roumania. These two countries formerly exported around 210,000,000 bushels, or about one-third of the international exports. The shipping situation also placed a premium upon North American supplies, and the farmer was guaranteed a minimum price more than twice as high as the prewar level. In consequence, wheat culture has been maintained and increased in

[3] Apart from the domestic consumption American flour has special foreign markets and an established export trade. This additional demand for wheat, either domestic or foreign, for reexport as flour is discussed on pp. 51, 52, in connection with the export trade.

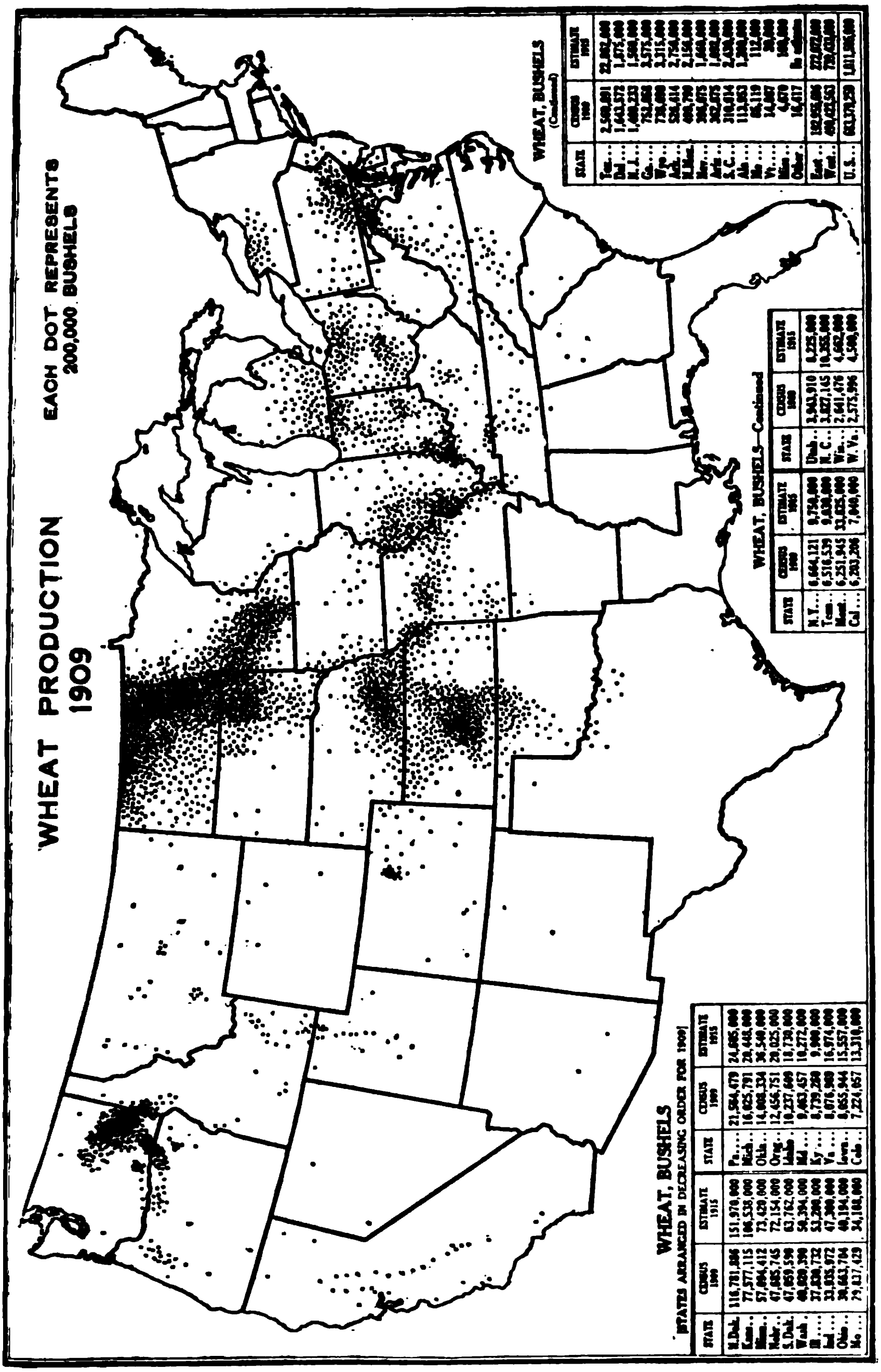
the regions producing at higher costs. For the five years, 1915–1919, however, the average harvest (831,000,000 bushels) was only about 100,000,000 bushels larger than for the preceding five-year period. It is noteworthy that, following the cessation of hostilities, only 53,000,000 acres, 20,000,000 less than in the preceding year, were sown to wheat in the crop year 1919–20; and that the large increase in the wheat acreage during 1918 and 1919 coincided with a reduced acreage in corn.

Price guarantees of exporting countries.—The minimum prices guaranteed by the different exporting governments during 1918–19 afford an interesting comparison. The American basic minimum, $2.26 at Chicago, or $2.39½ at New York, was widely stated to be below the cost of production. The Argentine minimum, at the port of export, was $1.55; the Australian minimum to producers was $1.14 during 1918–19, and for the crop of 1920–21 is $1.87. Differences in ocean freights were largely responsible for these variations. According to a special investigation of the United States Department of Agriculture,[4] the cost of production in the wheat belt for the crop of 1919 was $1.87 for winter wheat and $2.65 for spring wheat, the higher cost for the latter being chiefly due to unusually low yields. The average cost of winter and spring wheat was $2.15.

Former extensions of cultivation.—But in proportion to population there has been no increase in the national supply. The average per capita production declined from 8.2 bushels in 1882–1886 to 7.9 in 1915–1919; exports declined from 41.4 per cent of the crop of 1900 to only 19.1 per cent of that of 1913 (when they consisted mainly of durum and Pacific coast wheat and clear and low-grade flours), and were increased during the war period in part through a diminished consumption, while imports in 1918 attained a record figure of 28,000,000 bushels. Still more significant is the fact that the increase in production during the past 30 years coincided with a universal and progressive decline, even in the grain belt, in the proportion of the improved land sown to wheat. The national supply has been maintained partly by a slight increase in the average yield and chiefly by the new lands that were brought under cultivation. From the chief contributing cause of our increase—new farming areas—no further large contributions are to be expected. Wheat has been primarily a frontier crop. With the settlement of western lands the wheat belt has gradually moved westward, where grain could be grown under extensive cultivation

[4] *Weekly News Letter, United States Department of Agriculture, June 30, 1920.*—Fourteen representative districts were visited by field agents—9 winter wheat areas in Kansas, Nebraska, and Missouri, and 5 spring wheat areas in the Dakotas and Montana. Four hundred and eighty-one farms were surveyed.

to much better advantage than in the East. The older wheat-growing sections, although capable of larger yields under inten-



Map 2.—Wheat production in the United States. (From Yearbook, 1915, U. S. Department of Agriculture.)

-ive cultivation, have, in the face of western competition, found other forms of agriculture more profitable.

Doubtless the United States will continue to produce large quantities of wheat, more extensively north and west of the corn belt, that is, in the spring wheat region lying to the north, and in the dry-farming sections of the West, Southwest, and Pacific Northwest; and largely elsewhere, also, in crop rotations. It is, of course, as was demonstrated during the World War, largely a matter of price and comparative advantage.

The region east of the Mississippi, as well as the Southwest, must now import more than one-half the total wheat requirements. Here production has remained nearly stationary, population has increased more than twofold, and the share of the national wheat locally grown dropped from 62.2 per cent in 1871–1875 to 26.2 per cent in 1911–1915. During this period of nearly 50 years the production of the East North Central States, formerly the chief wheat-growing region, declined from 38.5 to 15.4 per cent of the total; here the proportion of the improved land in wheat fell from 18.1 per cent in 1879 to 7.9 per cent in 1909.[5]

It is the West North Central division that has contributed nearly all of the accretions to the national supply. From 1871 to 1915 its crop increased by about 350,000,000 bushels. Here also the maximum production appears to have been attained, while its surplus is diminishing. In this, the great surplus-producing section, the proportion of the improved land sown to wheat dropped from 19.2 per cent in 1879 to 15.7 per cent in 1909. Its average annual crop for the years 1916–1919 was approximately the same as in the preceding five-year period, despite high prices and appeals for a larger wheat production. Unfavorable climatic conditions were an important factor. In the Pacific States, which raise a relatively small surplus, production declined during 1916–1919.

The largest proportionate increase within recent years has taken place in the Mountain States, which raise only about 8 per cent of the national total. In this region of deficient rainfall, most of the crop is produced under irrigation and dry farming. Because of the intensive agriculture characteristic of farming under irrigation and of the competition of more productive farm products, no large increase is to be expected from irrigated farms. Neither are further large contributions to the national wheat supply to be expected from dry farming, for wheat is a precarious crop under such conditions. involves usually an alternate year of summer fallow, and the land is generally better adapted to grazing. Much of the area sown to wheat in this section during 1918 and 1919 will evidently revert to pasturage.

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[5] The data regarding the westward movement and geographic distribution of wheat production are from U. S. Department of Agriculture, Bul. 594, Geography of Wheat Prices, by L. B. Zapoleon.

TABLE 2.—*Wheat production and distribution, by States and sections, 1871 to 1915.*

(From Bulletin 894, U. S. Department of Agriculture.)

State and geographic division.	Production, in five-year averages, showing geographic distribution. [In thousands of bushels.]					Average 1911–1915 as compared with 1901–1905 (100 per cent).	Trend [illegible]										Per cent of all improved land occupied by wheat.[1]			
	1911–1915	1901–1905	1891–1895	1882–1886	1871–1875		1911–1915	1901–1905	1891–1895	1882–1886	1871–1875	1911–1915	1901–1905	1891–1895	1882–1886	1871–1875	1909	1899	1889	1879
United States	803,501	660,345	491,721	450,490	272,443	122	8.3	8.2	7.4	6.2	6.5	100.0	100.0	100.0	100.0	100.0	9.3	12.7	9.4	12.4
New England	107	226	462	1,187	937	47	(2)	(2)	.1	.3	.3	(2)	(2)	.1	.3	.3	.1	.1	.1	.6
Middle Atlantic	30,798	35,760	29,232	31,430	25,130	86	1.5	2.2	2.2	2.8	2.7	3.8	5.4	5.9	7.0	9.2	5.5	7.2	6.0	7.0
South Atlantic	37,187	32,877	27,874	26,566	20,570	113	2.9	3.0	3.0	3.3	3.2	4.6	5.0	5.7	5.9	7.6	4.6	7.3	6.4	9.0
East North Central	124,045	105,542	126,914	145,855	104,777	116	6.5	6.4	9.6	12.0	10.7	15.4	16.1	27.8	32.3	38.5	7.9	12.0	11.8	16.1
West North Central	416,425	345,102	202,973	156,639	71,183	121	34.5	32.1	21.7	21.6	15.7	51.8	52.3	41.3	34.8	26.1	15.7	18.5	12.6	19.2
East South Central	19,196	18,111	19,908	20,749	17,909	106	2.2	2.3	2.9	3.5	3.8	2.4	2.7	4.0	4.6	6.6	3.0	7.4	5.1	8.6
West South Central	41,381	33,447	9,100	6,763	2,524	124	4.3	4.6	1.7	1.7	1.0	5.2	5.1	1.9	1.5	.9	2.7	7.4	1.6	3.1
Mountain	59,765	22,593	8,355	7,324	336	265	20.3	11.5	6.2	8.4	.8	7.5	3.4	1.7	1.6	.1	8.1	11.2	6.0	10.9
Pacific	74,597	65,687	56,908	53,967	28,648	114	15.6	22.3	27.8	37.9	33.0	9.3	10.0	11.6	12.0	9.8	15.2	24.8	21.5	17.7
The Territories					2,429						6.0					.9				
New England.																				
Maine	80	192	199	584	271	42	.1	.3	.3	.9	.4	(2)	(2)	(2)	.1	.1	.1	.3	.1	1.3
New Hampshire			63	169	182		(2)	(2)	.2	.5	.6	(2)	(2)	(2)	(2)	.1	(2)	(2)	.1	.5
Vermont	27	34	197	379	411	79	.1	.1	.6	1.1	1.2	(2)	(2)	(2)	.1	.1	(2)	.1	.3	.8
Massachusetts				19	34		(2)	(2)	(2)	(2)	(2)	(2)	(2)	(2)	(2)	(2)	(2)	(2)	(2)	(2)
Rhode Island							(2)	(2)	(2)	(2)	(2)	(2)	(2)	(2)	(2)	(2)	(2)	(2)	(2)	(2)
Connecticut			3	36	39		(2)	(2)	(2)	(2)	.1	(2)	(2)	(2)	(2)	(2)	(2)	(2)	(2)	.1
Middle Atlantic:																				
New York	7,348	8,242	7,997	10,913	7,542	89	.8	1.1	1.2	2.0	1.6	.9	1.2	1.6	2.4	2.8	1.9	3.8	2.8	4.2
New Jersey	1,463	1,709	1,765	1,968	1,923	86	.5	.8	1.1	1.6	2.0	.2	.3	.3	.5	.7	4.6	6.7	6.1	7.1
Pennsylvania	21,987	25,809	19,570	18,549	15,665	85	2.7	3.8	3.5	4.0	4.2	2.7	3.9	4.0	4.1	5.7	9.7	11.5	10.0	10.8
South Atlantic																				
Delaware	1,936	1,681	1,269	1,062	632	115	9.3	9.6	7.3	6.3	4.8	.2	.3	.3	.2	.2	15.6	15.7	12.4	11.7
Maryland	9,981	11,618	7,387	7,444	5,036	86	7.5	9.5	6.8	7.6	6.1	1.2	1.8	1.5	1.7	1.9	17.6	18.0	15.0	17.0
Virginia	11,295	7,198	7,485	6,507	6,192	157	5.3	3.5	4.4	4.1	4.7	1.4	1.1	1.5	1.4	2.3	7.0	9.2	8.1	10.6
West Virginia	3,442	3,788	4,285	3,397	2,649	91	2.6	3.6	5.2	5.0	5.4	.4	.6	.9	.8	1.0	3.8	8.1	7.7	10.4
North Carolina	7,345	4,387	4,845	4,075	2,908	167	3.2	2.2	2.8	2.7	2.5	.9	.6	1.0	.9	1.1	5.7	9.0	8.5	10.0
South Carolina	1,199	1,949	905	1,276	820	62	.8	1.4	.7	1.2	.8	.2	.3	.2	.3	.2	.7	3.0	2.2	4.1
Georgia	1,989	2,256	1,698	2,805	2,533	88	.7	1.0	.9	1.7	2.0	.3	.3	.3	.6	.9	.8	3.0	2.1	5.8
Florida							(2)	(2)	(2)	(2)	(2)	(2)	(2)	(2)	(2)	(2)	(2)	(2)	(2)	(2)

See footnotes on p. 29.

TABLE 2.—*Wheat production and distribution, by States and sections, 1871 to 1915*—Continued.

State and geographic division.	Production, in five-year average graphic distribu [In thousands of b		
	1911–1915	1901–1905	1891 1895
East North Central			
Ohio	31,566	29,596	40,626
Indiana	34,950	27,858	38,412
Illinois	38,631	26,144	26,255
Michigan	15,198	14,759	21,900
Wisconsin	3,700	8,195	9,701
West North Central			
Minnesota	56,081	74,257	46,115
Iowa	14,098	14,680	13,197
Missouri	35,377	32,957	21,541
North Dakota	105,897	61,398	41,647
South Dakota	39,258	43,716	25,440
Nebraska	59,844	43,269	13,598
Kansas	102,690	74,835	41,437
East South Central:			
Kentucky	9,813	8,602	11,182
Tennessee	8,789	8,497	7,855
Alabama	528	982	748
Mississippi	66	30	123
West South Central			
Louisiana			
Texas	13,637	11,635	5,084
Oklahoma	26,217	19,600	2,464
Arkansas	1,527	2,212	1,562
Mountain			
Montana	23,930	2,587	1,173
Wyoming	2,366	560	121
Colorado	10,709	6,504	2,262
New Mexico	1,542	789	751
Arizona	879	418	239
Utah	6,691	4,221	2,086
Nevada	1,246	601	161
Idaho	15,523	6,913	1,562

See footnotes on p 29.

Pacific:																				
Washington	49,086	29,667	9,452	4,043	(1)	176	37.2	40.5	21.4	20.3	(1)	6.2	4.3	1.9	1.1	(1)	33.2	31.4	20.5	16.8
Oregon	18,018	14,506	11,245	13,135	3,440	124	23.8	20.5	32.2	56.6	20.7	2.2	2.2	2.3	2.9	1.3	17.9	26.2	15.7	20.9
California	6,504	22,612	36,216	35,689	23,206	29	2.5	12.9	26.0	35.7	35.6	.9	3.5	7.4	8.0	8.5	4.2	22.4	23.2	17.3
The Territories	.....	.....	.....	.....	2,429	.....	.....	.....	.....	.....	6.0	.....	.....	.....	.....	.9	.....	.....	.....	.....
	808,501	660,345	491,721	450,480	272,443	123	8.3	8.2	7.4	8.2	6.5	100.0	100.0	100.0	100.0	100.0	9.8	12.7	9.4	13.4
d																				
	188,748	140,036	170,624	128,087	66,087	.....	.....	(8)	(8)	(8)	(8)	.....	.....	.....	.....	.....	.....	.....	.....	.....
	26.5	21.2	24.7	26.4	24.2	[7] 125	[8] 1.9	1.7	2.6	2.3	1.6	.....	.....	.....	.....	.....	.....	.....	.....	.....

[1] Five-year averages, production divided by population. Average population calculated by prorating differences between decennial census periods.
[2]
[3]
[4]
[5] 1.
[6]
[7] 1-1908.
[8]

Sources of possible future increase.—Partially offsetting the factors which make for a diminishing wheat supply are (1) the probable increase through further accessions of farming areas, and (2) through higher yields to the acre, resulting from improved varieties and better cultural methods. From new farm lands no such large contributions as have occurred in the past seem probable, since large capital expenditures are required for irrigation, drainage, and the clearing of cut-over lands, and such areas are not likely to be sown to wheat. Yields to the acre—the second factor—are increasing slowly. But the more intensive wheat culture of the States east of the Mississippi has not withstood the competition of other crops and of the newer lands of the West. Whether it will be profitable in the West against the competition of such countries as Canada, Argentina, Russia, and Australia remains to be seen.[6] A suggestive parallel offers in the history of intensive wheat culture in central and western Europe, in the face of competition from the Americas and Russia. The high import duties imposed by some European countries have not served to free them of dependence upon foreign wheat.

But there is more immediate occasion for imports into the United States because of the great distances between the areas of surplus and deficient production, the nearness of the principal consuming markets to foreign sources of supply, and the character of the milling demand.

GEOGRAPHIC FACTORS AS A CAUSE OF IMPORTS.

Regions of surplus and deficient production.—The entire country east of the Mississippi, as well as the southern tier of western States from Texas to California, is a deficiency region; it is dependent upon the remaining trans-Mississippi States for a large part, and in the case of the Atlantic and Gulf States for nearly all, of its wheat. If production and consumption are considered by State units, 12 surplus-producing western States contribute nearly all of the gross surplus of the country, which during 1911–1915 averaged 424,000,000 bushels. (See Table 3.) Five of these States—Kansas, the Dakotas, Minnesota, and Nebraska—contribute about 60 per cent of the commercial supply. That is, they supply the great bulk of the exports and also ship larger quantities to deficiency regions in the United States. The degree of deficiency becomes progressively larger toward the east and south.

[6] Siberia and Manchuria are also possible sources of large supply in the future.

BLE 3.—*Wheat production, requirements, surplus, and deficiency by States and sections, 1911–1915.*

[Bul. 594, U. S. Department of Agriculture.]

tate and geographic division.	Population July 1, 1913 (median of 1911–1915).	Production (average 1911–1915).	Wheat ground in merchant mills in 1914.[1]	Shipments out of county where grown (approximate commercial movement). Average, 1911–1915.		Requirements, average, 1911–1915.	
						For food.	For food and seed.
	Thousands.	*Thousand bushels.*	*Thousand bushels.*	*Thousand bushels.*	*Per cent of production.*	*Thousand bushels.*	*Thousand bushels.*
United States.....	97,163	803,501	543,970	476,986	59.4	515,937	595,713
w England.....	6,865	107	519	(2)	(2)	33,245	33,405
dle Atlantic.....	20,570	30,798	56,604	10,516	34.1	113,223	117,318
th Atlantic [4].....	12,764	37,187	25,232	11,688	31.4	58,448	62,574
North Central.....	18,987	124,045	108,428	64,304	51.8	107,347	120,372
t North Central.....	12,057	416,425	242,970	273,765	65.7	71,237	112,100
t South Central.....	8,690	19,196	27,808	5,509	28.7	36,151	38,444
st South Central.....	9,516	41,381	29,971	27,118	63.5	48,656	53,424
un'ain.....	2,945	59,765	16,677	31,172	52.2	18,939	24,377
ific.....	4,769	74,597	35,761	52,914	70.9	28,691	33,699
w England:							
Maine.....	758	80	44	(3)	(3)	3,562	3,574
New Hampshire.....	437	.....	402	(3)	(3)	2,184	2,189
Vermont.....	360	27	15	(3)	(3)	1,944	1,946
Massachusetts.....	3,549	.....	57	(3)	(3)	17,744	17,838
Rhode Island.....	579	.....	.....	(3)	(3)	2,493	2,511
Connecticut.....	1,182	.....	1	(3)	(3)	5,318	5,347
dle Atlantic:							
New York.....	9,713	7,348	36,427	2,465	33.5	52,450	53,513
New Jersey.....	2,749	1,463	833	412	28.2	13,747	14,028
Pennsylvania.....	8,108	21,987	19,344	7,639	34.7	47,026	49,777
th Atlantic:							
Delaware.....	208	1,936	735	1,112	57.4	1,040	1,271
Maryland.....	1,330	9,981	5,310	5,971	59.8	6,651	9,070
Virginia.....	2,129	11,295	10,232	3,618	32.0	9,581	11,003
West Virginia.....	1,306	3,442	2,535	512	14.9	7,446	7,935
North Carolina.....	2,308	7,345	4,708	366	5.0	10,885	11,333
uth Carolina.....	1,572	1,199	100	18	1.5	6,760	6,950
orgia.....	2,737	1,989	1,617	91	4.6	10,947	11,242
rida.....	826	.....	.....	.....	.....	3,714	3,770
North Central:							
io.....	4,965	31,566	27,780	14,551	46.1	31,281	34,941
iana.....	2,761	34,950	21,200	19,116	54.7	15,737	19,479
ois.....	5,904	38,631	31,021	22,600	58.5	33,063	36,799
higan.....	2,937	15,198	14,621	7,154	47.1	14,683	16,187
sconsin.....	2,420	3,700	13,806	883	23.9	12,583	12,966
North Central:							
Minnesota.....	2,181	59,081	124,339	35,969	60.9	15,704	21,982
wa.....	2,222	14,098	7,118	9,159	65.0	11,779	13,215
souri.....	3,354	35,377	25,278	17,626	49.8	17,441	20,813
th Dakota.....	661	105,887	10,397	73,970	69.9	4,758	14,502
th Dakota.....	643	39,258	4,488	26,938	68.6	4,180	9,078
braska.....	1,233	59,844	11,405	40,126	67.1	7,152	11,884
nsas.....	1,768	102,880	59,945	69,977	68.0	10,223	20,626
uth Central:							
ntucky.....	2,336	9,813	13,114	2,892	29.5	10,513	11,650
nessee.....	2,238	8,789	14,579	2,575	29.3	9,176	10,168
bama.....	2,239	528	115	27	5.1	8,954	9,077
sissippi.....	1,877	66	.....	15	22.7	7,508	7,549
uth Central:							
isiana.....	1,745	.....	.....	.....	.....	7,855	7,907
as.....	4,172	13,637	18,979	7,477	54.8	22,529	24,099
lahoma.....	1,939	26,217	9,591	19,366	73.9	11,633	14,533
kansas.....	1,660	1,527	1,401	275	18.0	6,639	6,885
ain:							
ntana.....	419	20,900	4,143	13,025	62.3	2,515	5,284
oming.....	163	2,366	492	490	20.7	1,029	1,248
orado.....	883	10,709	5,738	5,558	51.9	5,300	6,107
w Mexico.....	370	1,542	291	304	19.7	2,924	3,061
zona.....	231	879	386	79	9.0	1,662	1,740
ah.....	405	6,601	2,525	2,221	33.6	2,469	2,951
vada.....	95	1,246	193	262	21.0	578	676
ho.....	379	15,522	2,909	9,233	59.5	2,462	3,310
ific:							
shington.....	1,345	49,985	17,567	37,749	75.5	8,068	10,940
gon.....	757	18,018	8,639	11,339	62.9	4,618	6,007
ifornia.....	2,667	6,594	9,555	3,826	58.0	16,005	16,752
ed States.....	97,163	803,501	543,970	476,986	59.4	515,937	595,713
plus.....	.....	.....	.....	.....	.....	.....	.....
domestic wheat)							
ge, 1911–1915.....	.....	.....	.....	.....	.....	.....	.....

[1] From census of manufactures, calendar year 1914. Grain ground in custom mills is not included. The ... indicate roughly the trade movement, wheat versus wheat flour.
[2] Less than 500 bushels. [3] Less than one-tenth of 1 per cent. [4] Includes District of Columbia.

TABLE 3.—*Wheat production, requirements, surplus, and deficiency, by States and sections, 1911–1915*—Continued.

[Bul. 594, U. S. Department of Agriculture.]

State and geographic division.	Average surplus or deficiency, 1911–1915.		Per capita.			Distribution in percentages of the United States total.		
	Surplus.	Deficiency.	Production.	Requirements.		Population.	Production.	Requirements for food and seed.
				For food.	For food and seed.			
	Thousand bushels.	*Thousand bushels.*	*Bushels.*	*Bushels.*	*Bushels.*	*Per cent.*	*Per cent.*	*Per cent.*
United States	207,788	.....	8.3	5.31	6.13	100	100	100
New England	.....	33,298	(1)	4.8	4.9	7.1	(2)	5
Middle Atlantic	.....	86,520	1.5	5.5	5.7	21.2	3.8	1
South Atlantic[3]	.....	25,387	2.9	4.6	4.9	13.1	4.6	1
East North Central	3,673	.....	6.5	5.7	6.3	19.5	15.4	2
West North Central	304,325	.....	34.5	5.9	9.3	12.4	51.8	1
East South Central	.....	19,248	2.2	4.2	4.4	9.0	2.4	0
West South Central	.....	12,043	4.3	5.1	5.6	9.8	5.2	9
Mountain	35,388	.....	20.3	6.4	8.3	3.0	7.5	4
Pacific	40,898	.....	15.6	6.0	7.1	4.9	9.3	5
New England:								
Maine	.....	3,494	.1	4.7	4.7	.8	(2)	.
New Hampshire	.....	2,189	(1)	5.0	5.0	.4	(2)	.
Vermont	.....	1,919	.1	5.4	5.4	.4	(2)	.
Massachusetts	.....	17,838	(1)	5.0	5.0	3.7	(2)	3
Rhode Island	.....	2,511	(1)	4.3	4.3	.6	(2)	.
Connecticut	.....	5,347	(1)	4.5	4.5	1.2	(2)	.
Middle Atlantic:								
New York	.....	46,165	.8	5.4	5.5	10.0	.9	9
New Jersey	.....	12,565	.5	5.0	5.1	2.8	.2	2
Pennsylvania	.....	27,790	2.7	5.8	6.1	8.4	2.7	8
South Atlantic:								
Delaware	665	.....	9.3	5.0	6.1	.2	.2	.
Maryland	911	.....	7.5	5.0	6.8	1.4	1.2	1
Virginia	292	.....	5.3	4.5	5.2	2.2	1.4	1
West Virginia	.....	4,493	2.6	5.7	6.1	1.3	.4	1
North Carolina	.....	3,988	3.2	4.5	4.9	2.4	.9	1
South Carolina	.....	5,751	.8	4.3	4.4	1.6	.2	1
Georgia	.....	9,253	.7	4.0	4.1	2.8	.3	1
Florida	.....	3,770	(1)	4.5	4.6	.8	(2)	.
East North Central:								
Ohio	.....	3,375	6.4	6.3	7.0	5.1	3.9	7
Indiana	15,471	.....	12.7	5.7	7.1	2.8	4.3	3
Illinois	1,832	.....	6.5	5.6	6.2	6.1	4.8	6
Michigan	.....	989	5.2	5.0	5.5	3.0	1.9	2
Wisconsin	.....	9,266	1.5	5.2	5.4	2.5	.5	2
West North Central:								
Minnesota	37,099	.....	27.1	7.2	10.1	2.2	7.4	3
Iowa	883	.....	6.3	5.3	5.9	2.3	1.8	2
Missouri	14,564	.....	10.5	5.2	6.2	3.4	4.4	3
North Dakota	91,385	.....	160.2	7.2	21.9	.7	13.1	2
South Dakota	30,180	.....	61.1	6.5	14.1	.7	4.9	1
Nebraska	47,960	.....	48.5	5.8	9.6	1.3	7.4	2
Kansas	82,254	.....	58.4	5.8	11.7	1.8	12.8	3
East South Central:								
Kentucky	.....	1,837	4.2	4.5	5.0	2.4	1.2	1
Tennessee	.....	1,379	3.9	4.1	4.5	2.3	1.1	1
Alabama	.....	8,549	.2	4.0	4.1	2.3	.1	1
Mississippi	.....	7,483	(1)	4.0	4.0	2.0	(2)	1
West South Central:								
Louisiana	.....	7,907	(1)	4.5	4.5	1.8	(2)	1
Texas	.....	10,462	3.3	5.4	5.8	4.3	1.7	4
Oklahoma	11,684	.....	13.5	6.0	7.5	2.0	3.3	2
Arkansas	.....	5,358	.9	4.0	4.1	1.7	.2	1
Mountain:								
Montana	15,616	.....	49.9	6.0	12.6	.4	2.6	.
Wyoming	1,118	.....	14.5	6.3	7.6	.2	1.9	.
Colorado	4,602	.....	12.1	6.0	6.9	.9	.3	1
New Mexico	.....	1,519	4.2	7.9	8.3	.4	1.4	.
Arizona	.....	861	3.8	7.2	7.5	.2	.2	.
Utah	3,650	.....	16.3	6.1	7.3	.4	.1	.
Nevada	570	.....	13.1	6.1	7.1	.1	.8	.
Idaho	12,212	.....	41.0	6.5	8.7	.4	.2	.
Pacific:								
Washington	39,045	.....	37.2	6.0	8.1	1.4	6.2	1
Oregon	12,011	.....	23.8	6.1	7.9	.8	2.2	1
California	.....	10,158	2.5	6.0	6.3	2.7	.9	2
United States	[4] 424,004	[4] 216,216	8.3	5.31	6.13	100	100	100
Net surplus	207,788	.....	.....	.....	.....	.....	.....	.....
Exp'ts (domestic wheat) average 1911–1915	188,748	.....	.....	.....	.....	.....	.....	.....

[1] Less than one-tenth of 1 bushel.
[2] Less than one-tenth of 1 per cent.
[3] Includes the District of Columbia.
[4] Gross surplus and deficiency.

Domestic wheat trade.—The domestic wheat may be roughly described as flowing in two great streams which have their source in central Idaho and western Montana. One stream moves westward toward the Pacific and branches off to California; the second and much larger stream flows eastward through the great surplus-producing States, and separates into Atlantic and Gulf branches.[7] The line of cleavage between the Pacific and eastern movement, as well as between the Atlantic and Gulf branches, is largely determined by the sum of the rail rates and ocean freights to Liverpool via the several routes. Because of prohibitive rail rates to the distant eastern regions of deficient production, the surplus Pacific wheat ordinarily can be shipped much more advantageously westward to foreign markets.

Pacific coast trade.—Usually, therefore, the crop of the Pacific Northwest, which is about 10 per cent of the total, enters into a distinct trade. It consists of both hard and soft wheat (winter and spring). The surplus is raised in eastern Washington and northeastern Oregon. With part of the Idaho and Montana wheat, it moves southward to meet California's deficiency of over 10,000,000 bushels (largely in the form of flour), or is exported from Pacific ports. But in the face of an increasing consumption, the production of the Pacific States has been declining (average for 1911–1915, 74,597,000 bushels; 1916–1919, 60,200,000). Moreover, the principal deficiency regions of California are over 1,000 miles from the surplus areas of the Pacific Northwest, and still more distant from Kansas and the Dakotas, which ship some quantities of hard wheat flour westward. Australia exports soft wheats that are highly esteemed in the world markets; and shipments from that country to California have been increasing since it obtained free admission to the United States of its wheat and wheat flour through the removal of its own customs duty. In the fiscal years 1918, 1919, and 1920 imports from Australia amounted to 3,475,079, 5,371,646, and 262,187 bushels, respectively.[8] In part the importations were due to war conditions, but during 1918 and 1919 the crop of the Pacific States was about 25,000,000 bushels short of the 1911–1915 average. In August, 1920, some Manchurian wheat was received on the Pacific coast. It is noteworthy that the Australian crop, as well as that of Argentina, is harvested in January and reaches the markets as a period when the domestic stocks are at the lowest point.

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[7] Relatively small shipments of Pacific wheat and flour are made to the southeast, and of Kansas and Dakota strong flours to the Pacific States. Because of the shipping situation much of the Pacific wheat moved eastward during the war.

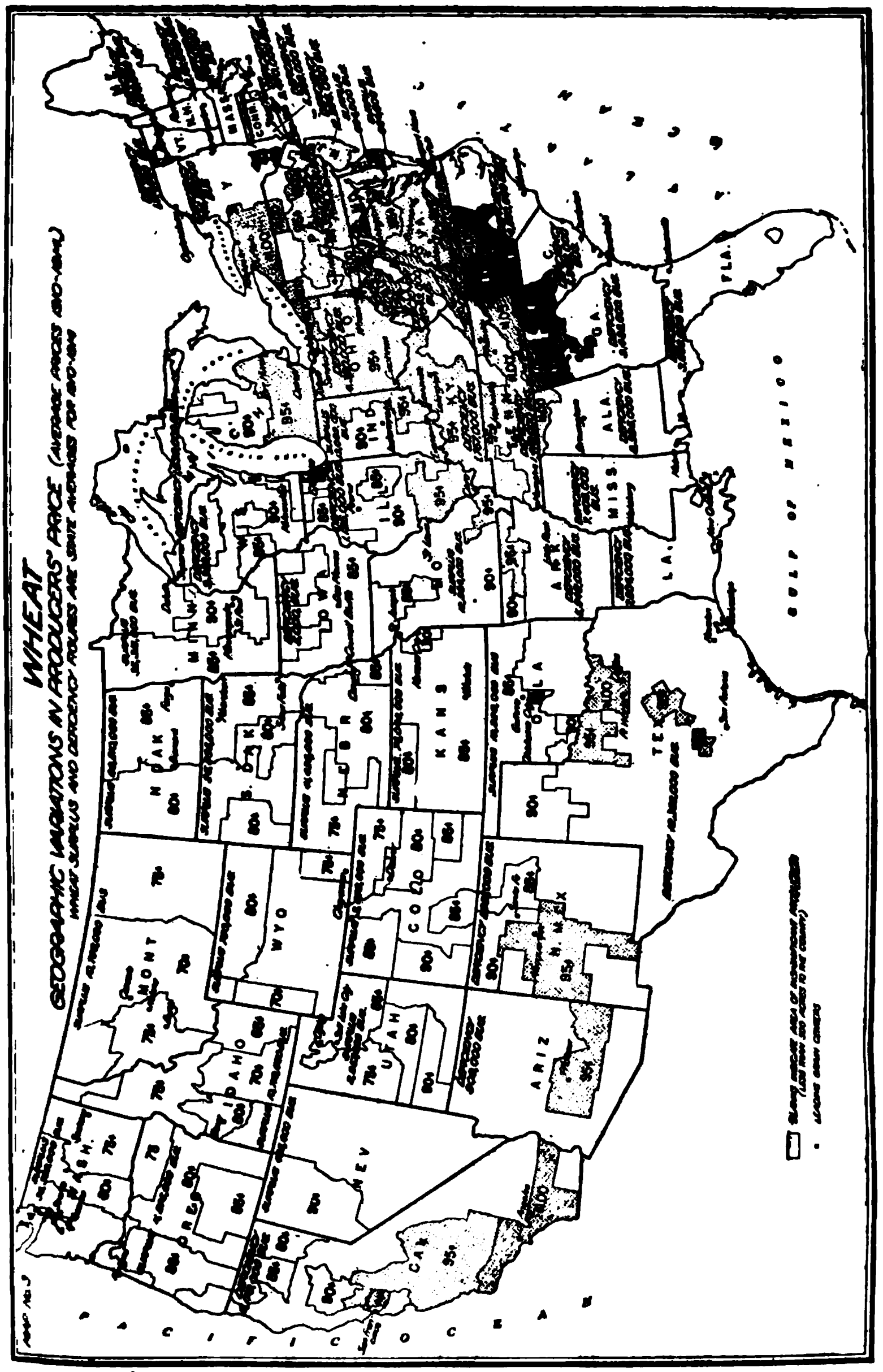
[8] Reexports of all foreign wheat (Australian, Argentine, and Canadian) amounted to 1,053,744 bushels in 1918, 498,762 in 1919, and 94,000 in 1920.

Atlantic and Gulf trade.—The movement eastward, commencing from the pivotal Idaho-Montana region and, progressively increasing in volume, passing through the trans-Mississippi grain belt—the world's greatest grain-growing region—is over eight times as large as that toward the Pacific. Either in the form of wheat or flour, it supplements the deficient local production of the South and of the States east of the Mississippi, and also carries most of the exports. In the earlier stages of its progress most of the grain is concentrated in five primary markets—Minneapolis, Duluth, Chicago, Kansas City, and St. Louis—for milling, local use, and reshipment. In connection with the future of foreign competition, it is significant that the subsequent eastern movement to the Atlantic seaboard parallels that of Canadian wheat and is swelled by the larger part of the Canadian exports, which are shipped in bond via this route to all countries.[9] Between the American and Canadian carrying interests there is keen competition for this traffic, and while some American wheat, corn, and oats are exported through Canada, ordinarily a far larger Canadian countercurrent moves through North Atlantic ports. Buffalo is the gateway for this eastward traffic; it receives nearly all of the wheat for consumption in and export from North Atlantic States, and also around 50,000,000 bushels annually of Canadian wheat (average for 1911–1915). Additional Canadian wheat is shipped directly to Portland, Me. When they are for domestic consumption the shipments to the east and south are largely in the form of flour. Most of the surplus spring wheat and flours, and a considerable portion of hard and soft winter, take this eastern route. Of lesser proportions are the shipments to the Gulf and southeast, for consumption and export, consisting chiefly of winter wheat and flour (hard and soft).

Geographic factors and imports; ocean freights versus rail rates.—The foregoing analysis of the domestic trade serves in some degree to indicate geographic factors which promise to exert a powerful influence upon the character and channels of foreign competition. The chief surplus-producing regions are 1,200 miles or more in the interior; and before the war rail rates to the seaboard markets were considerably higher than the ocean freights from foreign sources of supply. These seaboard markets absorb the bulk of the surplus wheat. The New England States receive for local consumption ap-

[9] Imports from Canada, for consumption, in 1917, 1918, 1919, and 1920, respectively, were 23,715,293, 24,690,105, 4,737,624, and 3,967,949 bushels. The large Canadian imports during the fiscal years 1918–1920, as well as the smaller Argentine and Australian shipments (see p. 57) were outside of ordinary commercial influences. They were arranged by the United States Grain Corporation, chiefly with a view to filling local shortages, and with the understanding also that equivalent quantities of flour would be released to the Allied Governments. Yet these purchases were made upon lower price bases than existed in the United States, and under the circumstances might have been caused by commercial influences had they been free to operate.

proximately 33,000,000 bushels (largely western wheat, and almost entirely in the form of flour); New York, Pennsylvania, and New Jersey an additional 86,000,000 bushels; the South Atlantic States



Map 3.—Regions of surplus and deficient production. (From Bul. 594, U. S. Department of Agriculture.)

about 25,000,000 bushels; the crop of the Gulf States from Alabama to Texas is ordinarily about 40,000,000 bushels, and that of California about 10,000,000 bushels short of requirements. To San Francisco and points farther south, the all-rail or rail-and-ocean freight rate from

the surplus-producing sections of the Pacific Northwest was higher, before the war, than from Australia to Liverpool—about 14 cents per bushel. To New York and New England points the rail rate from Kansas City was about 15 cents per bushel, while the ocean freight from Argentina was only around 8 cents. In the Southeastern States, which are most distant from domestic regions producing a large surplus, farm prices of wheat were about 25 cents per bushel higher than in the grain belt west of the Mississippi, and considerably higher than in the North Atlantic States. These southeastern States could have been reached by the Argentine product at approximately the same freight as to New York City—around 8 cents per bushel.[10] It is worthy of note that, partly because of higher prices, the consumption per capita in the South is much lower than in the northern States. Imports from Argentina amounted to 300,258 bushels in 1917, 1,006,595 in 1919, and 501,111 in 1920.

More important than the movement from Argentina and Australia to Atlantic, Gulf, and Pacific markets is the pressure of Canadian wheat on the north. Thus the metropolitan district of New York City alone consumes annually around 30,000,000 bushels, and it receives for export an approximately equal quantity of Canadian grain under bond. The removal of the tariff barriers makes the Canadian wheat readily available for domestic consumption throughout the principal deficiency regions. (Map 3, page 35, shows surplus and deficiency by States and variations in producer's prices. It gives an indication of the channels of trade.)

Account should, of course, be taken of the fact that ocean freights are now higher than rail rates, though in the United States the latter have also nearly doubled since 1914. By September, 1920, ocean freights on wheat from Argentina to Atlantic seaboard points fell from the war levels to around 30 cents per bushel; and from Australian to Pacific seaboard points to around 45 cents per bushel. The current rail rate (for domestic consumption) to San Francisco from Spokane is 28.5 cents per bushel, and from Kansas City, 51.3 cents. To southeastern seaboard points the rate from Kansas City is 34.5 cents per bushel, and to New Orleans, 22.8 cents. The all-rail domestic rate from Minneapolis to New York is 28.5 cents. Wheat prices in Australia and Argentina during the war were much below those prevailing in the United States. Ordinarily the market of these countries is in Europe, and especially in the United Kingdom. Unless ocean freights suffer a great reduction it is only under unusual conditions that substantial competition from Australia and Argentina is probable. But with respect to Canada, the chief source of imports, conditions are different.

[10] Large grain imports in the southeastern seaboard markets would require the development of greater handling facilities than are at present available.

DEMAND FOR DIFFERENT KINDS OF WHEAT AS A CAUSE OF IMPORTS AND EXPORTS.

Domestic wheat consumption.—The domestic consumption of flour was estimated to be 94,102,000 barrels for the crop year 1917–18 (equivalent to about 426,564,000 bushels of wheat)[11] with over 3,500,000 tons of mill feed as a by-product. About one-half of the flour is ordinarily consumed in home baking of bread, biscuits, pastry, and similar breadstuffs; the consumption by bakers in baking bread is around 36,000,000 barrels; a further 10,800,000 barrels are used in other bakery products such as biscuits, crackers, cake, macaroni, breakfast foods, and similar breadstuffs, of which biscuit and cracker manufacturers use around 3,500,000 barrels.[12] A relatively small use is made of wheat in breakfast foods and many food specialties; also in the manufacture of starch and its numerous derivatives. For replanting, around 85,000,000 bushels, or about 10 per cent of the crop, are consumed. The lower grades, or "feed" wheat, are fed to pigeons, poultry, and other live stock. In the semiarid regions, where wheat is sometimes lower priced than corn, wheat is occasionally substituted as a feedstuff. The consumption on farms for feed varies from 13,000,000 to over 26,000,000 bushels, chiefly according to the quality of the harvest.

Uses of different kinds of wheat.—The demand is not for wheat in general, but for specific kinds and qualities to meet particular uses. In consequence the United States, or some part of the country far distant from domestic sources of supply of certain needed qualities, has sometimes found it necessary to import one quality while exporting others. Three principal classes are recognized commercially: soft, hard, and durum, or macaroni, wheat. Differences in quality or grade of the principal classes constitute a further cause of imports.[13] In connection with the tariff problem it is important to note the commercial and individual uses of these chief types.

The climatic conditions under which wheat is grown exercise a great influence upon the character and quality of the crop. The product of humid climates is usually soft and yields starchy flours, while drier climates produce a hard grain that yields a flour higher in protein. Hard wheat usually gives "strong" flours, producing a well-risen and lighter loaf of even texture; it has a greater capacity

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[11] Grain and Flour Statistics during the War. U. S. Grain Corporation, 1918, p. 27.

[12] These figures are rough estimates, based upon the report of the U. S. Food Administration for the year 1918. In estimating the disposition of the crop, allowance should be made for a loss in cleaning of around 5 per cent of the wheat handled by the mills, and a further loss of about 1½ per cent in the milling process.

[13] These subordinate grades are based principally upon test weights (as an indication of milling yield), color (a white flour is in demand for the principal breadstuffs), moisture content, percentage of foreign materials, and of heated or otherwise damaged kernels.

for absorbing water in the baking process, and hence yields larger quantity of bread per barrel—a distinct advantage to t baker or large-scale producer. On the other hand, soft wheats a preferable for pastry, crackers, biscuits, cakes, pies, and similar pro ucts, being flaky or crumbly and free from the undesirable toughn which characterizes strong flours when used for these purposes. breadmaking soft, weak wheats produce a more compact loaf, quiring less lard or other shortening. For the best results in cooki both classes are therefore required. Durum wheat yields a ha granular flour with a larger quantity and different quality of p tein than hard wheat, and in strength is intermediate between s and hard wheat. These qualities render it especially desirable f macaroni, spaghetti, and similar pastes. Its yellow color, wh renders it undesirable for the white flours desired by bakers, exc for blending purposes, is highly prized by macaroni manufacture

Competition of different kinds of wheat.—For breadmaking, wh absorbs perhaps three-fourths of the wheat flour, the strong ha wheats are therefore preferred. But about one-half the flour s is for household consumption, and for ordinary household purpo varieties of the highest strength are not desirable; very good bre can be made from flour of moderate strength, and such flour is fai well adapted to most of the uses to which soft wheats are put. milling practice it is customary to mix different classes and grad the mixtures varying according to price and seasonal variations quality. During recent years, as a result of more scientific milli wheat has been bought for constituent elements of the grain rat than on the basis of arbitrary grades. Of the hard wheats, the spri varieties are usually stronger, but give a lower milling yield than t hard winter, and vary more in milling quality from year to ye For general flour-making purposes many millers prefer the ha winter wheat. Wheat of excessive strength is especially in dema for blending. It is the problem of the miller to maintain standa grades of flour while blending dark hard wheats with soft we wheats of good color, and to bring the mixture up to the same degr of strength. Bakers, whose requirements differ somewhat from tho of the millers, also find it desirable to mix different types of flou if prices justify, they can increase the mixture of soft flours and b care and skill maintain the quality of their bread output.[14]

To a large extent, therefore, the different classes of wheat a competitive. It is true that there are certain classes of consume who must have a particular class or grade, and this results in a pri

[14] One barrel of flour (196 pounds) will produce from 275 to 290 1-pound loaves bread.

premium for that kind in years of shortage; but the larger proportion of the crop is used by manufacturers who can substitute, more or less, one variety or quality for another when prices warrant. In general, however, the higher grades of wheat (which yield more flour and are more cheaply handled) are preferred by American millers, and their domestic market is largely for the higher grade or patent flours made from these better wheats, leaving a considerable surplus of low-grade wheats and clears and low-grade flours for export. A large crop of wheat may therefore be accompanied by an actual shortage of the higher grades desired for milling purposes or for seed. In the crop year 1919–20, for instance, there was a large surplus of soft wheats, but a shortage of hard wheats, especially of the higher grades. The price of No. 1 Northern spring rose about $1 per bushel above that of the better grades of soft wheat. Of hard springs, Canada has a large surplus; the Canadian Wheat Board raised its guaranteed price of spring wheat 80 cents per bushel, of soft wheats by a smaller amount, and opened offices in the United States to dispose of the Canadian product in the premium markets. In other years soft wheat has frequently sold at a premium.[15]

PRODUCTION AND DISTRIBUTION OF CHIEF CLASSES.

In the United States.—The durum wheats, drought and rust-resistant varieties especially suited to semiarid regions, were introduced from southeastern Russia in 1898. Durum is grown chiefly in the western part of the Dakotas, and in Montana, where it has made rapid headway. Between the years 1914 and 1919 the crop was from 16,000,000 to 43,867,000 bushels—on an average less than 3 per cent of the national production. About 50 per cent of the crop is exported, chiefly to Italy and other Mediterranean countries, durum constituting fully a fifth of the wheat (grain) exports during 1910–1913. Of the other exporting countries, only Russia and Algiers produce a large surplus of this class, Canada's production being relatively insignificant. A considerable proportion of the American exports is returned in the form of macaroni and other edible pastes, annual imports of which before the war amounted to around $5,000,000. Because of the cessation of imports during the war, the American consumption of durum wheat and the manufacture of edible pastes has considerably increased. For the flour obtained as a by-product in the manufacture of durum semolina there is virtually no domestic outlet, and this flour is usually exported.

[15] The Grain Corporation offered to sell straight flours made from soft wheat to the household trade (especially in the northern States) at a very considerable reduction below the price of patent hard flours. This effected a material reduction in the price spread between the two kinds.

TABLE 4.—*Durum wheat: Receipts at primary markets and exports, 1910–1919.*

[From Monthly Crop Reporter, U. S. Department of Agriculture.]

	1910	1911	1912	1913	1914
EXPORTED FROM—	*Bushels.*	*Bushels.*	*Bushels.*	*Bushels.*	*Bushels.*
Duluth	[1] 5,613,329	[1] 2,480,807	[1] 45,000	[1] 1,216,000	[1] 2,448,000
Portland, Me	844,732			507,000	142,000
Boston	539,719	361,931	46,000		315,000
New York	7,725,273	158,458	1,569,000	11,215,000	6,920,000
Philadelphia	2,575,452	123,024	184,000	2,141,000	1,568,000
Baltimore	948,007	149,483	8,080	382,000	389,000
Newport News					
New Orleans	26,460				
Port Arthur	72,000				
Galveston					
Total	18,344,972	3,273,703	1,852,000	15,461,000	11,785,000
RECEIVED AT—					
Chicago	[2] 832,800	1,151,000	472,000	472,000	673,000
Duluth	21,927,425	6,807,000	3,074,000	14,419,000	14,215,000
Kansas City					
Milwaukee					
Minneapolis	11,193,800	11,232,000	2,157,000	6,590,000	4,720,000
Omaha	[2] 213,000	[2] 242,000	75,000	207,000	379,000
St. Louis	[2] 460,000	[2] 332,000	52,000	851,000	638,000
Total (substantially the domestic production)	34,627,025	19,764,000	5,830,000	22,539,000	20,625,000

	1915	1916	1917	1918	1919
EXPORTED FROM—	*Bushels.*	*Bushels.*	*Bushels.*	*Bushels.*	*Bushels.*
Duluth	1,704,000	861,583	75,000		780,274
Portland, Me	206,654				
Boston	352,584	846,152			819,020
New York	8,258,031	13,214,456	10,732,000	4,807,962	10,572,758
Philadelphia	4,513,819	7,107,434	5,288,941	864,572	4,189,180
Baltimore	73,710	2,379,368	119,767		1,477,796
Newport News		267,176	10,500		
New Orleans	120,603			915,261	400,189
Port Arthur					90,040
Galveston		104,000			
Total	15,229,401	24,780,169	16,226,208	6,587,795	18,329,257
RECEIVED AT—					
Chicago	231,400	464,400	529,200	146,400	346,800
Duluth	15,624,000	34,278,890	13,485,911	6,081,374	25,432,253
Kansas City			60,000		
Milwaukee		38,000	72,500	58,500	115,000
Minneapolis	4,618,000	7,872,630	7,614,300	7,548,700	7,170,540
Omaha	686,400	1,143,600	673,200	2,175,000	214,800
St. Louis	196,800	69,600	68,400	78,000	32,400
Total (substantially the domestic production)	21,356,600	43,867,120	22,503,511	16,087,974	33,311,793

[1] Via Canada. [2] Six months, July–December, 1909. [3] Assuming 1,000 bushels per car.

Nearly all of the domestic crop consists of hard and soft wheats in greatly fluctuating but, on an average, approximately equal proportions. East of the Mississippi the crop consists almost exclusively of soft wheats, largely fall sown. The relatively small "shipments out of counties where grown" indicate that the crop is consumed locally.[16] Hard western wheats constitute the great bulk of the shipments to this deficiency region, enabling the export of some quantities of the soft local wheat. It is worthy of note that the wheat consump-

[16] See Table 8, p. 82.

tion of the Southern States is to a greater degree in such products as biscuits and cakes, for which the local soft wheats are better utilized. In the great surplus-producing West North Central division the crop consists principally of hard wheats—hard spring wheat in the Dakotas and Minnesota, hard winter in Kansas and adjacent States. The strong wheat of these States constitutes the bulk of the commercial wheat, and the great development of the wheat trade of the United States since 1880 coincided with the rapid increase of production in this region.[17] In the mountain States the harvest consists of both hard and soft varieties in uncertain proportion, while the crop of the Pacific States consists largely of soft and semihard wheats. Both the deficiency State of California and the surplus-producing Pacific Northwest receive considerable quantities of hard western wheats for blending purposes.

In other countries.—The chief importing countries of Europe produce almost exclusively soft wheats. Though importing some quantities of such wheats, their demand is especially for the strong varieties, the markets for which have been increasing much faster than, and perhaps at the expense of, the soft types. Of the chief exporting countries, Canada ships almost exclusively strong spring wheats; Australia, soft wheats that are highly esteemed because of their excellent color and high milling yield; the United States and Russia, chiefly hard, but also soft and durum wheats; British India, hard varieties of only fair strength; while the crop of Argentina is largely of hard and semihard varieties.

WHEAT PRODUCTION IN CANADA.

It has been seen that the character and channels of the trade as well as the milling demand for hard wheat point to Canada as the chief competitor. There the production and surplus of wheat have both shown a rapid increase. In 1871 the total reported production was 16,723,000 bushels; in 1891, 42,223,000; in 1913, 231,717,000; and in 1915 it had increased to 393,542,000 bushels, the largest crop ever produced in the Dominion. In the area sown to wheat, however,

[17] The commercial demand for more wheat in the United States and Canada has resulted in the introduction and development of varieties adapted to a wide range of climatic conditions. Hard spring wheat, although introduced in the northern Great Plains and Canada about the middle of the last century (probably from the Volga River Valley district of Russia) did not become firmly established until after 1870, coincident with the introduction of the purifier and roller mill. These improvements, allowing a completer separation of the milled products, enabled the miller to produce from the strongly colored middlings of hard wheat a flour suited in color and texture to the popular demand.

Hard winter wheat was introduced into the middle Great Plains by Russian Mennonite emigrants from the Black Sea region, about 1873. (Yearbook, U. S. Dept. of Agr., 1914.)

The most notable recent acquisition has been the development in Canada, and rapid spread in the United States, of Marquis wheat, a high-milling and early-maturing variety of hard spring wheat especially adapted to cold, dry climates. Early maturing varieties have considerably extended the northern limits of cultivation in Canada.

there has been a steady increase, that of 1919 amounting to 19,141,000 acres, or about three times that of 1908. The three prairie Provinces, i. e., Manitoba, Saskatchewan, and Alberta, produce around 90 per cent of the total crop and ship substantially all of the exports. They produce hard spring wheat of excellent quality and of the type greatly in demand in Europe and the United States. The output of the eastern Provinces, consisting of soft varieties, also largely spring sown, has always been relatively small. Although they have shown some increase in the yield per acre, their total acreage and production have, for the most part, declined. In British Columbia also the quantity of wheat produced has always been insignificant.

Prior to 1900 Ontario was the principal wheat-growing section, but with the opening of the prairie Provinces that place was taken by Manitoba, and after 1908 by Saskatchewan, which now raises about one-half the Canadian crop. Meanwhile there was a decline in wheat acreage in the eastern Provinces, not unlike that which had taken place in the eastern section of the United States as a result of the competition of western wheat. In the face of a small domestic consumption, of the competition of hard wheats in the world markets, and of high import duties in the large consuming centers south of the border, farmers in the eastern Provinces of Canada have found it more profitable to devote their time to dairying, fruit growing, and diversified agriculture. During the war, however, the production of the eastern Provinces showed a considerable but relatively unimportant increase. It is possible that the removal of the tariff barriers to the North Atlantic States may stimulate production in these Provinces, though the same factors which have decreased the wheat acreage in the eastern part of the United States are in operation in Canada.

The westward movement of the Canadian wheat belt is shown in Table 5.

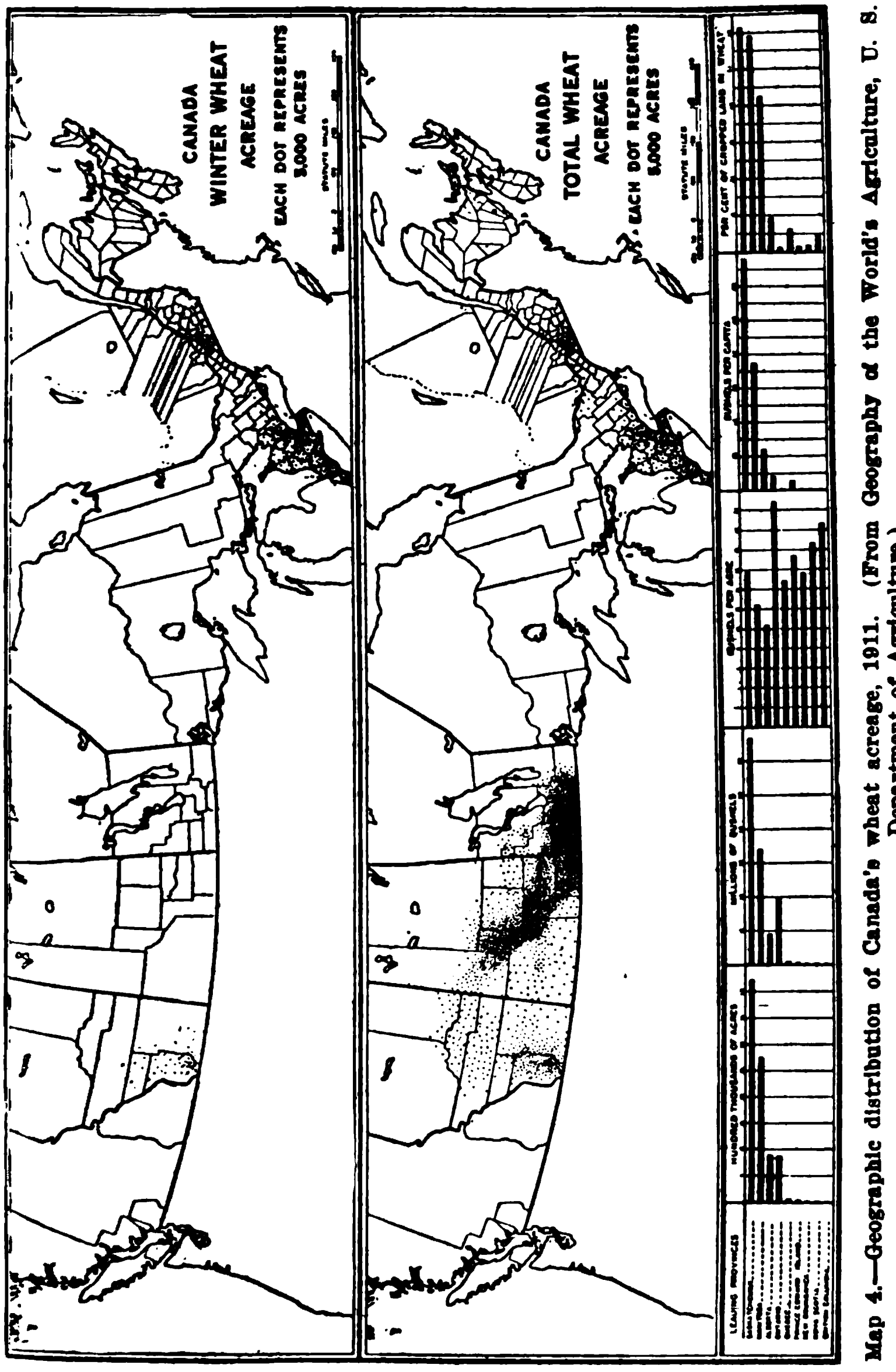
TABLE 5.—*Canadian wheat acreage, 1890–1919.*

[From Canadian Yearbooks and Census and Statistics Monthly.]

Province.	1919	1915	1910	1900	1890
	Acres.	*Acres.*	*Acres.*	*Acres.*	*Acres.*
Canada	19,141,337	15,109,415	8,863,151	4,224,542	2,701,24
Saskatchewan	10,587,363	8,929,260	4,228,222	487,212	} 113,81
Alberta	4,282,503	2,138,031	879,301	43,062	
Manitoba	2,880,301	2,800,424	2,760,371	1,965,200	896,62
Ontario	980,644	1,093,000	870,355	1,487,633	1,430,53
Quebec	251,089	71,000	61,143	139,826	168,92
New Brunswick	35,641	14,000	13,384	26,990	17,30
Nova Scotia	28,931	13,300	12,152	16,334	14,15
Prince Edward Island	35,595	34,400	28,721	42,318	44,70
British Columbia	59,270	16,000	9,502	15,967	15,18

COMPARATIVE PRODUCTIVITY AND COST.

Although the Canadian wheat crop, from year to year, is far less than that of the United States, it is increasing at a much more rapid



Map 4.—Geographic distribution of Canada's wheat acreage, 1911. (From Geography of the World's Agriculture, U. S. Department of Agriculture.)

rate. (See Table 6.) Canada's harvest of hard spring wheat now usually exceeds that of the United States, while the yield of the

higher grades of this class is usually larger. Since 1908 the area devoted to wheat in the Dominion has trebled, whereas in this country the acreage has, on the whole, remained stationary between 1899 and 1913, and increased nearly 50 per cent by the close of the war period (1919).[18] Moreover, the wheat land of Canada is much more productive. Under methods of cultivation substantially like the methods in vogue in this country, the average yield per acre for 1908 to 1919, inclusive, was 17.6 bushels, compared to an average yield of 14.6 bushels in the United States. With a wheat acreage in 1915 (a year of record production in both countries) equivalent to one-fourth the acreage in the United States, the wheat crop in Canada was more than one-third as large. Canada's superior productivity is even more striking when a comparison is made between the principal wheat-growing States and Provinces, and especially the hard spring wheat producing regions. (See Table 9, p. 47.)

TABLE 6.—*United States and Canada compared in wheat acreage, production, yield per acre, and test weight per bushel, 1902–1920.*

Year.	Total wheat acreage.		Wheat production.		Average yield per acre.		Average weight per bushel.[3]	
	United States.[1]	Canada.[2]	United States.[1]	Canada.	United States.[1]	Canada.[2]	United States.	Canada.
	Acres.	*Acres.*	*Bushels.*	*Bushels.*	*Bushels.*	*Bushels.*	*Pounds.*	*Pounds.*
1902	46,202,000	.....	670,063,000	.....	14.5	.....	57.6	.....
1903	49,465,000	.....	637,822,000	.....	12.9	.....	57.3	.....
1904	44,075,000	.....	552,400,000	.....	12.5	.....	57.4	.....
1905	47,854,000	.....	692,979,000	.....	14.5	.....	55.5	.....
1906	47,306,000	.....	735,061,000	.....	15.5	.....	58.3	.....
1907	45,211,000	.....	634,087,000	.....	14.0	.....	58.2	.....
1908	47,357,000	6,610,300	664,602,000	112,434,000	14.0	17.00	58.3	59
1909	46,723,000	7,750,400	737,189,000	166,744,000	15.8	21.51	57.9	59
1910	45,681,000	8,463,151	635,121,000	132,048,782	13.9	14.89	58.5	59.
1911	49,543,000	11,100,673	621,338,000	230,924,000	12.5	20.80	57.8	59
1912	45,814,000	10,996,700	730,267,000	224,159,000	15.9	20.38	58.3	59
1913	50,184,000	11,015,600	763,380,000	231,717,000	15.2	21.04	58.7	60
1914	53,541,000	10,295,900	891,017,000	161,280,000	16.6	15.87	58.0	59
1915	60,469,000	15,109,415	1,025,801,000	393,542,600	17.0	26.05	57.9	60
1916	52,785,000	15,369,709	636,318,000	262,781,000	12.2	17.10	57.1	57
1917	45,089,000	14,735,850	636,655,000	233,742,850	14.1	15.75	58.5	59
1918	59,181,000	17,353,902	921,438,000	189,075,350	15.5	11.00	58.8	58
1919[4]	73,243,000	19,125,968	940,987,000	193,260,000	12.8	10.00	56.3	56
1920[4]	53,652,000	18,232,374	750,648,000	293,361,000	14.0	16.00	57.4	58

[1] Yearbook of the Department of Agriculture.
[2] The Canada Yearbooks. Authentic figures prior to 1908 not available.
[3] The Canadian average weights are for an Imperial bushel; the American, for a Winchester bushel which is equivalent to 0.9694 of the Imperial bushel. The American average weight is raised by a much larger proportion of the heavier soft winter wheat.
[4] Preliminary estimates.

Such comparable cost investigations as have been published officially in the two countries bear out the conclusion that the cost of producing wheat is higher in the United States than in Canada

[18] Nearly all of this gain was lost in the crop year 1920–21, when the area sown to wheat was 20,000,000 acres less than in 1919–20. It is also noteworthy that the American acreage in spring wheat has remained nearly stationary since 1898, at around 18,000,000 acres. While this acreage consists largely of hard spring, several million acres are devoted to soft spring and durum. The production of all spring wheat constitutes, on an average, about one-third of the American total. Canada's severe winter prevents a large increase in the acreage in winter wheat.

For the year 1909 the United States Department of Agriculture secured estimates from 5,338 of its regular crop correspondents as to the cost of producing wheat. In Canada a similar investigation was made for the year 1911, when "effective" replies were received from 1,089 correspondents. The result of these investigations is given, in part, in Tables 7 and 8. It is, of course, not as the present absolute cost that these figures are given; they are reproduced merely as an approximation of relative costs during 1909–1911. Present costs may not have increased in equal measure in both countries.

These results afford a rough comparison for 1909–1911, even though there is some difference in the treatment of individual items as well as a lapse of two years between the dates of investigation.[19] Without any allowances for the different conditions in the two years, the cost of producing a bushel of wheat appears to have been about 4 cents lower in Canada, as a whole, than in the United States; approximately 10 cents lower in Ontario, Quebec, and New Brunswick than in New York, Ohio, and Indiana (States and Provinces producing chiefly soft winter wheat); while in the prairie Provinces, notably Alberta, the cost was well below the cost reported for Minnesota and the Dakotas (hard spring wheat) and for Kansas (chiefly hard winter wheat). Cost comparisons for other States and Provinces are of less significance for the present purpose because they are not within the chief wheat-producing areas.

TABLE 7.—*Cost of producing wheat per acre and per bushel in the United States, 1909, as estimated by correspondents.*[1]

	United States.	New York.	Ohio.	Indiana.	Illinois.	Minnesota.
Commercial fertilizer	$0.58	$2.50	$1.76	$1.20	$0.27	$0.18
Preparation	$2.11	$4.23	$2.86	$2.57	$2.01	$1.90
Seed	$1.42	$2.20	$1.75	$1.51	$1.50	$1.59
Planting	$0.46	$0.61	$0.48	$0.41	$0.35	$0.42
Harvesting	$1.33	$1.95	$1.40	$1.12	$1.19	$1.35
Preparing for market	$1.48	$1.94	$1.49	$1.54	$1.46	$1.34
Miscellaneous	$0.48	$0.66	$0.41	$0.45	$0.43	$0.55
Land rental or interest on land value	$3.30	$3.91	$4.22	$4.79	$5.33	$2.67
Cost per acre	$11.16	$18.00	$14.37	$13.59	$12.54	$10.00
Yield per acre, 1909 (bushels)	17.2	23.4	18.3	17.8	19.5	16.4
Cost per bushel upon basis of yield in the year 1909	[2] $0.66	$0.77	$0.79	$0.76	$0.64	$0.61
Yield per acre,[3] 1910–1914 (bushels)	14.8	20.4	15.9	15.5	16.0	13.6
Average cost per bushel,[4] 1910–1914	$0.75	$0.88	$0.90	$0.87	$0.78	$0.73

[1] Crop Reporter, May, 1911, p. 36.
[2] As given in Crop Reporter, May, 1911, p. 36. By calculation the amount should be $0.648.
[3] Average of yields reported by the yearbooks of the Department of Agriculture.
[4] The quotient of the cost per acre as reported by correspondents and the average yield per acre, 1910–1914.

These results should not be taken too literally. In the first place, comparatively few farmers keep accurate accounts of cost, and the cost figures, as returned by correspondents, are only rough estimates of their own costs as farmers or of the costs on representative farms in their respective communities.

In the second place, it must be remembered that cost is a variable and uncertain element. While the farmer's expenditure (cost per acre) *may* remain much the same over short periods of time, there is frequently a marked variation in yield and therefore in cost per bushel. An average yield for the five years, 1910–1914, was therefore calculated.

TABLE 7.—*Cost of producing wheat per acre and per bushel in the United States, 1909, as estimated by correspondents*—Continued.

	North Dakota.	South Dakota.	Montana.	Washington.	Nebraska.	Kansas.
Commercial fertilizer	$0.06	$0.11	.....	$0.38	$0.09	$0.06
Preparation	$1.95	$1.46	$2.55	$2.36	$1.48	$1.81
Seed	$1.31	$1.38	$1.36	$1.24	$1.28	$1.22
Planting	$0.44	$0.41	$0.54	$0.49	$0.44	$0.41
Harvesting	$1.03	$1.18	$1.72	$1.72	$1.22	$1.49
Preparing for market	$1.60	$1.22	$2.05	$1.94	$1.38	$1.44
Miscellaneous	$0.38	$0.39	$1.00	$0.54	$0.49	$0.45
Land rental or interest on land value	$2.22	$2.83	$3.25	$4.43	$3.70	$3.41
Cost per acre	$8.99	$8.98	$12.47	$13.10	$10.08	$10.29
Yield per acre, 1909 (bushels)	14.4	14.4	28.6	25.0	18.3	16.3
Cost per bushel upon basis of yield in the year 1909	$0.62	$0.62	$0.44	$0.52	$0.55	$0.63
Yield per acre,[3] 1910–1914 (bushels)	10.4	9.8	23.3	21.9	16.8	15.3
Average cost per bushel,[4] 1910–1914	$0.86	$0.91	$0.53	$0.59	$0.60	$0.67

[3] Average of yields reported by the yearbooks of the Department of Agriculture.
[4] The quotient of the cost per acre as reported by correspondents and the average yield per acre, 1910–1915.

TABLE 8.—*Cost of producing wheat per acre and per bushel in Canada, 1911, as estimated by correspondents.*[1]

	Canada.	Nova Scotia (soft wheat).	New Brunswick (soft wheat).	Quebec (soft wheat).	Ontario (soft wheat).	Manitoba (hard spring wheat).	Saskatchewan (hard spring wheat).	Alberta (hard spring wheat).	British Columbia (soft wheat).
Commercial fertilizer	.....	$5.62	.....	.....	.....	.....	.....	.....	.....
Preparation	$3.10	$3.85	$3.00	$3.08	$4.32	$2.16	$3.21	$3.13	$5.27
Seed	$1.74	$2.78	$2.20	$2.31	$1.79	$1.43	$1.33	$1.56	$2.34
Seeding and cultivation	$1.00	$1.11	$1.00	$1.69	$1.16	$0.80	$0.91	$0.71	$1.34
Harvesting	$1.55	$3.16	$2.10	$1.76	$0.76	$1.26	$1.17	$1.61	$2.19
Thrashing	$2.32	$2.05	$1.68	$1.88	$1.70	$2.38	$2.81	$2.59	$3.07
Wear and tear of implements	$0.48	$0.40	$0.33	$0.40	$0.39	$0.44	$0.45	$0.43	$0.41
Rental value	$2.68	$2.34	$4.00	$3.12	$2.98	$3.00	$2.30	$2.35	$5.06
Cost per acre	$12.87	$21.31	$14.31	$14.24	$14.10	$11.47	$12.18	$12.38	$19.68
Yield per acre, 1911 (bushels)	21	21	22	21	21	21	20	24	28
Cost per bushel upon basis of yield in the year 1911	$0.61	$1.01	$0.65	$0.67	$0.67	$0.54	$0.60	$0.51	$0.70
Yield per acre,[2] 1910-1914 (bushels)	18.4	20.4	18.5	16.8	22.0	17.8	18.3	20.4	26.8
Average cost per bushel,[3] 1910-1914	$0.69	$1.04	$0.77	$0.80	$0.64	$0.64	$0.66	$0.60	$0.73

[1] Census and Statistics Monthly, March, 1912, pp. 54–56.
[2] Average of yields as reported by the Canada Yearbook, 1915, pp. 146–168.
[3] The quotient of the cost per acre as reported by correspondents and the average yield per acre 1910-1914.

Perhaps a better measure of comparative productivity and cost is afforded by such data as are collated in Table 9, showing production, average yields and gross returns per acre, rate of wages, and land values. It will be seen that, although producers' prices are lower in the Dominion, yields are materially larger; and so also are the gross returns per acre. Moreover, usually a larger proportion of the Canadian crop is of the better grades. Land values are also very much below those obtaining south of the border. Higher labor costs offset these advantages, but this factor is of small importance

on the acreage basis, since it requires only from 10 to 15 hours of man labor to produce an acre of wheat. Wheat growing is a type of agriculture that requires a minimum of labor and supervision, and that during only a few months of the year. On the other hand, the crop is a soil exhauster, and the farmer is at the mercy of the elements; a single frost may destroy the marketable quality of his entire crop; hail, rust, and the Hessian fly often cause severe damage. One unfavorable season may almost ruin the grain farmer. In both quantity and quality the yield of spring varies more than does winter wheat. The latter is, in general, more productive, and its labor requirements are better distributed throughout the year. Moreover, throughout much of the American winter wheat region grass is seeded with the small grains, thus saving the expense of preparing the land for subsequent grass crops.

TABLE 9.—*Comparative productivity and cost: Wheat growing in the United States and Canada.*

[From U. S. Crop Reporter and Canada Census and Statistics Monthly.]

[5-year averages, 1915–1919, unless otherwise noted.]

State and Province.	Production	Yield per acre.	Farm price per bushel.	Gross returns per acre (yield and price per bushel).	Average wages regular farm help per month (including board).	Average value of farm lands (United States, plow land; Canada, occupied land).
	Bushels.	*Bushels.*			1919.	1919.
North Dakota	86,911,800	11.3	$1.49	$15.58	$56.00	$37.00
Saskatchewan	130,991,260	15.9	1.52	22.36	76.00	32.00
South Dakota	43,610,000	13.1	1.45	19.70	66.00	67.00
Alberta	45,800,240	20.3	1.35	24.55	81.33	29.00
Minnesota	52,629,000	14.7	1.52	23.32	53.70	78.00
Manitoba	45,268,180	16.7	1.45	23.67	74.08	35.00
Illinois	42,209,000	17.9	1.55	27.84	43.50	144.00
Idaho	19,480,060	22.4	1.54	33.74	57.58	66.00

An important advantage possessed by Canada is in the quantity of unoccupied land still available for wheat growing. It is stated by Canadian authorities that there is land enough in the great hard wheat belt of the prairie country west of the Red River and Lake Winnipeg to produce a very large portion of the world's present demand (see Table 10), and the development of early-maturing varieties is extending the wheat-raising areas. "The combined area of the three prairie Provinces is 466,068,000 acres, of which only about 14 per cent is now occupied as farm land; and it is estimated that fully one-half of this area is suitable for farming. Agricul-

turists maintain that it is the largest continuous expanse of rich soil on the American Continent. It is favored not only with a rich top soil but also with a deep subsoil containing an abundance of nitrogen, phosphoric acid, and potash, so that many successive crops can be taken from the land without the use of fertilizers. This land will doubtless not be fully utilized for many years, but it bids fair to maintain indefinitely the superiority in wheat production which Canada now enjoys."[20]

TABLE 10.—*Areas occupied and possible farm land in Canada, 1914.*

[From the Canada Yearbook, 1914, p. 208.]

Province.	Total land (acres).	Occupied as farm land, 1911.		Estimate of possible farm land.	
		Acres.	Per cent.	Acres.	Per cent.
Prince Edward Island	1,397,991	1,202,354	86.01	1,258,000	9
Nova Scotia	13,483,671	5,260,455	38.01	8,090,000	6
New Brunswick	17,863,266	4,537,999	25.44	10,718,000	6
Quebec	442,153,287	15,613,267	3.53	44,212,000	1
Ontario	234,163,030	22,171,785	9.47	58,544,000	2
Manitoba	148,432,698	12,228,233	8.24	74,216,000	5
Saskatchewan	155,764,100	28,642,985	18.39	93,459,000	6
Alberta	161,872,000	17,751,899	10.96	105,217,000	6
British Columbia	226,186,370	2,540,011	1.12	45,237,000	2
Total	1,401,316,413	109,948,988	7.84	440,951,000	31

It appears very doubtful, however, whether the present rate of increase in wheat acreage and production can long be maintained, and such predictions realized. Frost, drought, damage by hail, rust, and other causes, the uncertainty and hardships of grain farming in western Canada; such factors impose severe limitations upon future increases. Moreover, the same necessity for diversified farming which has decreased the wheat acreage in the eastern part of the United States, and is in operation in the principal American wheat-raising sections as well as in eastern Canada, eventually will also affect the western Provinces. In Manitoba its influence is already in evidence. But the fact remains that Canada has had an exportable surplus of from 82,000,000 to 223,000,000 bushels during 1913 to 1919; that her wheat is of the type especially desired for bread flours; and that the channels of trade, as will later be seen, are so directed that the bulk of her exports already move in bond through the principal American consuming centers, for export to Europe. The shortage of the North Atlantic States alone is approximately 120,000,000 bushels.

[20] The Canada Yearbook, 1914, p. 208.

EXPORT TRADE OF CANADA AND THE UNITED STATES.

Export markets.—A comparison of the Canadian and American export trade in wheat and flour reveals a striking contrast. From 1902 to 1914—leaving out of consideration the war period, which has stimulated exports and restricted consumption in the two countries—Canadian exports of both wheat and flour showed a rapid increase. In the United States, exports of flour were maintained or slightly increased since 1909; but exports of wheat—the raw material—had dwindled to a small proportion of the national harvest. From 1911 to 1914, inclusive, the Canadian exports of grain greatly exceeded those of the United States. In 1912, 1917, and 1918 Canada's combined exports of wheat and flour exceeded those of this country.

Canada usually exports around 70 per cent of her crop. Of the much larger American harvest only about 20 per cent is normally exported. Hard spring wheat and spring flour constitute nearly all of the Dominion's shipments. Such wheat and flour have constituted a steadily diminishing proportion of the American exports. In the years 1910–1914 about 16 per cent of the flour exports came from Minneapolis, Duluth, and "Northwestern" mills, less than 9 per cent of the output of these mills; and hard spring wheat was only a part of the product from which this flour was ground.

Canadian wheat and flour have a much narrower foreign market than the American product; but within their chief foreign markets, especially in the United Kingdom, the growing Canadian exports have displaced much of the trade formerly enjoyed by the United States. Over 90 per cent of the Canadian exports normally goes to the United Kingdom, as compared to about 30 per cent of the American shipments. The remainder of Canada's exports usually moves to Newfoundland, the British West Indies, and the United States. But the United States ordinarily ships much larger quantities to central and western Europe, where the demand for strong wheat and flour is not so pronounced as in the United Kingdom. And American wheat and flour enters into a world-wide trade—to the Orient, Central and South America, Europe, and Africa. Since the World War, however, the Canadian product has also begun to move in considerable volume to these markets, in competition with American exports.

TABLE 11.—*Export trade in wheat and wheat flour: United States and Canada, 1902–1920*

[From United States Commerce and Navigation returns, fiscal years ending June 30; Canada, Year-books, fiscal years ending Mar. 31.]

Year.	Exports from the United States.					Exports from Canada.				
	Wheat and wheat flour.		Wheat.		Flour.	Wheat and wheat flour.		Wheat.	Flour.	
	Total.	Per cent of production.				Total.	Per cent of production.			
										Barrels
1902	23,115,031	31.37	15,002,020		17,103,184	3,146,332	33.92	30,045,000		1,086,648
1903	20,196,113	30.23	11,020,869		19,184,132	3,192,128	38.58	45,287,000		1,287,766
1904	12,613,016	15.92	4,069,532		16,132,128	2,128,128	28.06	28,587,000		1,587,600
1905	4,110,007	7.99	602,135		8,135,163	2,128,128	27.52	15,321,000		1,321,489
1906	9,107,014	14.09	3,091,483		13,163,163	4,165,128	42.06	62,532,000		1,532,014
1907	14,125,095	19.95	7,223,167		15,167,167	3,181,128	38.06	27,092,000		1,092,123
1908	16,109,095	25.71	10,657,147		13,147,161	5,198,128	54.68	68,962,000		1,962,740
1909	11,168,095	17.19	6,644,161		10,161,187	5,220,128	49.73	49,738,000		1,738,038
1910	8,118,095	11.85	4,076,187		9,187,135	6,176,128	38.10	50,064,000		3,064,028
1911	6,100,095	10.91	2,602,135		10,135,187	5,223,128	30.68	15,049,000		3,049,046
1912	7,104,095	12.83	3,112,187		11,187,135	5,148,128	37.65	36,738,000		3,738,535
1913	14,107,095	19.57	9,074,135		11,105,135	10,108,128	54.62	69,478,000		3,478,043
1914	14,109,095	19.07	9,075,135		11,151,187	14,103,128	68.82	79,832,000		4,832,183
1915	33,176,095	37.31	25,033,187		16,765,135	9,101,128	59.53	55,952,000		4,952,337
1916	24,126,095	23.70	17,015,135		15,109,187	18,132,128	43.71	69,400,000		6,400,214
1917	20,128,095	31.99	14,027,187		11,[illegible],778	22,100,128	34.88	46,425,000		7,425,725
1918	13,150,095	21.05	9,053,187		21,879,951	19,103,128	33.46	67,931,000		9,931,148
1919	28,167,095	31.20	17,073,187		24,190,092	8,171,128	43.72	44,196,000		9,196,[illegible]
1920	21,142,095	23.36	12,024,187		21,651,261	11,143,128	60.02	67,863,000		8,863,068

American milling demand outstripping national wheat production.—In a sense, wheat is a competitor of flour in the world trade. The wheat movement is seasonal, and the demand is general—that is, the wheat of the United States and of Canada competes with that of Argentina, Russia, Australia, and British India. Flour, on the other hand, is sold under brand and the brand itself is in demand. And its movement is more evenly distributed throughout the year. American flour has established markets and a specific demand. As the domestic consumption is largely in the form of the higher-priced patent flours, there is a constant surplus of clears and low grades. For such reasons wheat exports fluctuate greatly, according to harvests, while the shipments of flour vary comparatively little.

In seven of the nine fiscal years 1906–1914 the relatively small American shipments of grain consisted in large part of durum wheat, for which there was then only a limited domestic demand, and of the special trade of the Pacific coast. In other words, the domestic supply of hard and soft wheats was falling below the combined requirements of domestic consumption and the export flour trade. The shortage was making itself especially felt in the higher grades.

TABLE 12.—*Wheat and wheat flour exported from the United States, 1910–1919, by ports.*

	1910	1911	1912	1913	1914
Wheat (bushels):					
Atlantic ports	19,537,203	9,136,590	15,922,283	42,998,326	46,431,465
Gulf ports	4,177,748	290,802	1,252,637	28,789,815	22,595,643
Pacific ports	10,674,471	11,687,842	10,544,382	13,815,533	11,761,995
Other ports	12,290,454	2,614,068	2,440,910	5,999,300	11,604,672
Total	46,679,876	23,729,302	30,160,212	91,602,974	92,393,775
Deduct:					
Durum wheat [1]	18,344,972	3,723,703	1,852,000	15,461,000	11,785,000
Pacific wheat	10,674,471	11,687,842	10,544,382	13,815,533	11,761,995
Wheat flour (barrels):					
Atlantic ports	5,773,759	5,961,708	5,612,664	6,185,046	6,228,403
Gulf ports	1,250,797	2,450,280	1,488,029	1,788,705	2,205,675
Pacific ports	1,699,986	1,522,694	3,802,780	3,267,199	3,137,004
Other	316,445	194,753	103,014	153,855	250,379
Total	9,040,987	10,129,435	11,006,487	11,394,805	11,821,461

	1915	1916	1917	1918	1919
Wheat (bushels):					
Atlantic ports	110,546,920	106,899,692	92,262,688	26,194,679	116,961,560
Gulf ports	102,678,709	48,528,965	48,365,252	6,795,086	25,292,214
Pacific ports	20,320,979	10,293,729	3,068,200	926,042	1,318,086
Other ports	26,095,925	7,551,629	6,135,287	203,046	35,010,813
Total	259,642,533	173,274,015	149,831,427	34,118,853	178,582,673
Deduct:					
Durum wheat [1]	15,229,401	24,780,169	16,226,208	6,587,795	18,329,257
Pacific wheat	20,320,979	10,293,729	3,068,200	926,042	1,318,086
Wheat flour (barrels):					
Atlantic ports	10,355,262	9,793,610	7,710,340	13,317,237	16,621,362
Gulf ports	3,073,647	3,107,130	2,713,521	6,890,056	4,108,975
Pacific ports	2,542,667	2,330,773	1,030,438	1,437,916	3,098,378
Other ports	211,189	289,156	488,479	234,742	353,264
Total	16,182,765	15,520,669	11,942,778	21,879,951	24,181,979

[1] Wheat exports from 1916 to 1909 were as follows:

Exports of wheat (grain):	1906	1907	1908	1909
Durum (bushels)	7,015,225	22,638,565	27,053,478	20,777,435
Pacific wheat (bushels)	14,437,539	13,624,905	28,834,549	11,003,274
	21,452,764	36,263,470	55,888,027	31,780,709
Total wheat exports	34,973,291	76,569,423	100,371,057	66,923,244

Preferential markets for American flour.—The maintenance of the American export trade in flour, as opposed to declining grain exports, has thus been due in varying degree to a number of factors; to the large domestic demand for the higher-priced flour, leaving a surplus of the lower grades; perhaps also, indirectly, to the enormous domestic demand for the by-products of milling, chiefly for feeding purposes; to the efficiency of the milling industry, which has developed foreign markets for its product; and particularly to special advantages in a number of foreign and territorial markets. In Cuba,

American shippers enjoy a tariff preferential of 3.2 cents per bushel on wheat and 34.7 cents per barrel on flour; in Brazil, a preference of 30 per cent on flour, or 29.7 cents per barrel; in the Philippines American wheat and flour enter free of duty, while against other countries a duty is assessed of 6.8 cents per bushel of wheat and 41.8 cents per barrel of flour; and there is also a special market in the Territories of Porto Rico, Hawaii, and Alaska. The average shipments to these markets during 1910–1914 amounted to 10,134,034 bushels. It is therefore apparent that American millers and exporters may import much foreign wheat into the United States with a view to releasing for export equivalent quantities of domestic wheat and flour.

It is also noteworthy that under the Canada-West Indies agreement of June 18, 1920, the preferential given Canadian flour in these markets was increased to not less than one shilling (at par 24.3 cents) per barrel.[21] Under the former agreement of April 9, 1912, the preference was 12 cents per barrel. As a result of these preferences Canadian flour has rapidly displaced the American product in this market for approximately 550,000 barrels.

TABLE 13.—*Exports to preferential markets for American wheat and flour. Average shipments from the United States, 1910–1914.*

Shipped to—	Total wheat and flour.	Wheat.	Wheat flour.
	Bushels.	*Bushels.*	*Barrels.*
Brazil	2,554,365	867	567.4
Cuba	3,881,774	28,698	856,2
Philippines	1,254,236	9	278,7
Hawaii	660,542	98,230	124.9
Porto Rico	1,529,214	60	339.5
Alaska	253,903	.....	56,4
Total	10,134,034	127,864	2,223,5

During the same period American exports to Mexico, where the United States has the advantage of propinquity, annually averaged 1,178,864 bushels of wheat and 31,314 barrels of flour.

WHEAT TRADE BETWEEN THE UNITED STATES AND CANADA.

In the foregoing sections a comparison has been made between Canada and the United States with respect to wheat acreage and production, exports, and cost per bushel. The United States has reached her zenith as an exporting country, whereas Canada, with an excellent quality of the strong wheats preferred in the principal world markets, a lower cost of production, a growing surplus, and large areas of land yet uncultivated, has become one of the greatest surplus wheat areas of the world. In spite of the fact that both

[21] In Trinidad, British Guiana, Barbados, St. Lucia, Bermuda, British Honduras, Jamaica, Leeward Islands, Windward Islands.

countries have been wheat-exporting nations, there are a number of reasons why wheat should cross the boundary line. The commerce between the two countries may be considered under the two general headings of (1) transportation and the transit trade and (2) imports for consumption.

TRANSPORTATION AND TRANSIT TRADE.

Transit trade.—Transportation, perhaps, complicates the three-cornered trade relations between England, Canada, and this country more than any other factor. The organization of the trade routes is by no means simple, but the general rule may be laid down that during the summer the traffic in Canada moves east and west. Geographically the Great Lakes and the St. Lawrence River favor such a movement, and the economic differences between the eastern and western Provinces reinforce the tendency. Likewise, because of political connection, the trade sets toward England rather than toward the United States. Supplementary to these forces are the railways which have developed into transcontinental lines and to whose facilities traffic tends to accommodate itself.

Inadequacy of Canadian port and shipping facilities.—To such an extent have these factors reinforced each other that, so far as the transportation rates alone are concerned, the Canadian route to Liverpool in the open season draws considerable quantities of American wheat and other grain. This is especially true in the summer, before the large movement of Canadian grain takes place, but when American facilities are taxed by the enormous movement of winter wheat, corn, oats, and other crops. The rates on Canadian wheat from the interior to Montreal are lower than to the United States ports,[22] and the Montreal liners will carry wheat across the Atlantic at rates not exceeding those of the liners from New York or other United States ports.

But the amount of Canadian exports moving by way of American ports is ordinarily greater than that shipped directly from Canada, despite the fact that transportation to Liverpool is no higher through Canadian channels, and that, while Montreal and the lake ports are closed for about five months, St. John (New Brunswick), and Halifax are open throughout the year.

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[22] According to the report of the Canadian Board of Grain Commissioners (1917), the export rail rate from Fort William and Port Arthur to Montreal was 9.5 cents per 100 pounds; to St. John, New Brunswick, Halifax, New York, and Boston, 23.7 cents. For recent changes, see Table 13, p. 58.

TABLE 14.—*Transit trade in wheat and flour between the United States and Canada, 1907–1920.*

WHEAT.

Year.	Canadian exports through American ports.[1]						American exports through Canadian ports.
	Baltimore.	Boston.	New York.	Philadelphia.	Portland (Maine.)	Total.	
	Bushels.	*Bushels.*	*Bushels.*	*Bushels.*	*Bushels.*	*Bushels.*	*Bushels.*
1907	[illegible]	7 [illegible] 89	[illegible] 5	2 [illegible] 76	4 [illegible] 65	[illegible]	(2)
1908	[illegible]	7 45	5	2 84	5 [illegible] 20	[illegible]	1,304,411
1909	[illegible]	7 09	7	5 49	4 [illegible] 80	[illegible]	10,822,214
1910	[illegible]	8 53	5	4 53	6 [illegible] 86	[illegible]	10,689,993
1911	[illegible]	6 58	2	2 91	3 [illegible] 59	[illegible]	3,972,514
1912	[illegible]	10 08	2 0	11 70	5 [illegible] 50	[illegible]	2,074,730
1913	[illegible]	12 64	1 7	10 57	6 [illegible] 25	[illegible]	7,373,392
1914	[illegible]	14 97	2 5	11 67	9 [illegible] 61	[illegible]	6,052,036
1915	[illegible]	6 02	1 7	3 89	6 [illegible] 68	[illegible]	33,522,079
1916	[illegible]	13 06	3 7	14 32	27 [illegible] 49	[illegible]	10,944,496
1917	[illegible]	13 45	6 8	7 25	14 [illegible] 77	[illegible]	944,290
1918	[illegible]	2 08	2	4 09	19 [illegible] 79	[illegible]	1,320,227
1919	.....	09	9	06	16 [illegible] 79	[illegible]	316,779
1920	.....	.....	3	.....	10 [illegible] 00	[illegible]	220,497

FLOUR.

	Barrels.	*Barrels.*	*Barrels.*	*Barrels.*	*Barrels.*	*Barrels.*	
1907	3,507	56,083	265,131	29,071	105,873	459,665	.....
1908	321	125,308	199,514	49,884	130,978	506,105	.....
1909	9,639	142,482	275,891	36,600	110,568	575,200	.....
1910	530	244,066	723,573	61,282	170,394	1,199,835	.....
1911	11,356	249,232	657,048	43,271	184,403	1,145,310	.....
1912	29,033	319,024	660,765	118,569	237,129	1, 20	.....
1913	86,767	352,289	800,145	159,027	196,849	1, 77	.....
1914	60,727	232,718	929,020	236,338	200,914	1, 17	.....
1915	45,635	225,302	1,258,558	204,237	190,496	2, 34	.....
1916	193,406	711,353	1,520,702	421,926	209,732	[3] 3, 78	.....
1917	115,206	928,439	1,384,446	117,691	472,462	2, 43	.....
1918	6,403	62,306	819,771	3,804	1,007,961	1, 11	.....
1919	.....	.....	814,869	.....	1,020,531	1, 00	.....
1920	.....	202,323	618,068	1,379	539,552	1, 22	.....

[1] Additional quantities of Canadian grain and flour go to the United States lake ports and pass back from them to Canadian routes and ocean ports.

[2] Includes the ports of Virginia, which exported 717,495, 142,685, and 646,706 bushels of transit wheat in 1914, 1915, and 1916, respectively; also, 1,429 barrels of transit flour in 1916. From Grain Statistics, Report Department of Trade and Commerce, Canada, Pt. V and Pt. I.

So far as concerns Halifax and St. John, not only are the freight rates higher than to Montreal, but their facilities are as yet inadequate for more than a small proportion of the grain traffic. Moreover, the regular ocean trade of these cities and of Montreal is small compared with that of the American ports, and when their shipping capacity is full the excess goes south of the border. In other words, they have neither docks nor ships enough to take care of the peak load in autumn or in May. It is useless to enlarge the docks unless more ships will come; and this requires a greater import trade. The American ports are better able to handle the surplus, as well as the domestic grain, not only because of the greater number of liners but also of the supply of tramp vessels, which prefer the southern route on account of lower rates of marine insurance and the greater certainty of obtaining a cargo.[23] Although tramps actually carry

relatively little grain, they are always a potential factor in rate making for the liners.

Rail and lake traffic congestion in the Canadian west.—A similar congestion exists with respect to the lake and rail traffic in the west. It has been seen that nearly all of the Canadian wheat is produced in the western Provinces. Owing to the peculiar geographical and economic features of western Canada, the main lines of the three Canadian railways in this vast territory are so built that they converge toward Winnipeg; they then lead to Fort William and Port Arthur on the lake front, 420 miles distant, through a rocky and unproductive region. Through Winnipeg, the primary market of western Canada, passes nearly all of the Canadian wheat. It has been estimated that, in the record year 1915, an average of a thousand cars of wheat was handled through this market every working day. The length of time between harvesting and the close of navigation at the head of the Lakes is only about 70 days, and the cost of the rail haul from the western lake ports to Montreal is about twice as high as by water. Apart from the highly seasonal character of the rail-and-lake traffic, with the consequent inadequacy of transportation, and the absence of a large return trade, a vast amount of seasonal credit is required to finance this movement; hence a rapid marketing of the western grains—not only of wheat, but of oats, flaxseed, and barley—by all the available routes, is to the general interest. Canadian exports of wheat and flour in 1918, for instance, amounted to over $450,000,000. The retention of grain in the elevators until the reopening of navigation involves interest and storage charges, faces the uncertainties of the price situation, competition from the January harvest of Argentina and Australia and the later harvest of British India.

Still another phase of the situation is that the navigation laws force some use of American facilities. Only Canadian vessels can carry between Canadian ports, while the larger American inland fleet may transport wheat from a Canadian to an American port only. Between 3,000,000 and 4,000,000 tons of American coal are brought to Fort William and Port Arthur by American freighters; and these ships carry back large quantities of grain, especially in November and December, when the American eastbound ore trade falls off and much of the American fleet is laid up or diverted to other traffic. Moreover, the Canadian canals between Lake Erie and Montreal are too small to take boats carrying over 2,200 tons.

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[a] Report of conference between Canadian Minister of Commerce and representatives of various subsidized shipping lines regarding the increasing diversion of grain to American ports. The shipping interests denied that Canadian rates were higher and blamed the lack of shipping facilities at Montreal. It was also pointed out that tramp steamers will not go to Montreal owing to the uncertainty of obtaining a cargo and because rates of marine insurance are higher than at New York. (Hay Trade Journal. Nov. 3, 1913.)

TABLE 15.—*Comparative summary of Canadian and United States lake vessel carrying Canadian grain for the season of navigation, 1909–1916.*

[From Canadian Board of Grain Commissioners, 1917, p. 275.]

CANADIAN VESSELS.

Season of navigation.	Number.	Total capacity.	Average capacity.	Number of cargoes carried.	Quantity of grain carried.	Average quantity per cargo.	Percentage carried by Canadian and United States vessels.
		Bushels.	Bushels.			Bushels.	Per cent
1909	81	[illegible]700	76,951	.....	16	.....	
1910	89	100	97,747	.....	18	.....	
1911	90	100	99,466	.....	14	.....	
1912	93	100	102,227	.....	13	.....	
1913	102	100	113,343	.....	10	.....	
1914	103	100	122,980	751	13	124,068	
1915	94	100	127,532	662	16	130,708	
1916	84	100	134,167	895	2	169,000	

UNITED STATES VESSELS.

1909	66	15,473,000	234,439	.....	18,710,817	.....	
1910	62	15,238,000	245,774	.....	20,056,901	.....	
1911	126	30,147,000	239,262	.....	35,602,951	.....	
1912	184	34,900,000	226,624	.....	55,943,671	.....	
1913	209	53,230,000	253,514	.....	96,132,198	.....	
1914	68	23,535,000	267,443	138	33,224,473	240,757	
1915	225	58,151,000	258,448	452	106,513,046	235,648	
1916	189	43,470,500	230,002	565	104,714,386	185,335	

In the United States, also, transportation facilities are taxed during the peak of the grain movement, but the harvest period ranges from May and June in the South to late September in the North, and the marketing is better distributed throughout the year. Other factors of advantage are a great return movement of eastern products, a large number of competing primary markets, the competing eastern Gulf, and Pacific routes, and a heavy domestic consumption, which in most years absorbs around 75 to 80 per cent of the crop. The elimination of the tariff barrier renders available to Canada the mechanism of the great primary markets and milling centers south of the border and also opens the consuming markets. The former import duty of 25 cents per bushel was nearly prohibitive (except with respect to the transit trade in bond), being five times as high as prewar ocean rates to Liverpool.

Canadian transportation and shipping subsidies.—Note should be made of the measures taken by the Canadian Government to relieve the situation and to keep the northern wheat moving through all Canadian channels. Besides cash and other subsidies to railways Government-owned lines and vessels, mail subsidies and steamship subventions, Government elevators have been established, grain grades standardized, and a Government railway 410 miles in length through Manitoba to Port Nelson, on Hudson Bay, is well on the way to completion. It is hoped that this northern route will lessen

the congestion during the four months of open navigation and provide shorter and quicker transportation to Liverpool.[24] Government elevators have also been established on the Pacific coast, with a view to shipping via the Panama Canal.

Canada is developing the means of moving her crop (except when unusually large harvests occur) through her own ports, with the assistance of Portland, Me. Portland, because of geographical situation and railroad connections, is the natural outlet for Canada's produce, and it has become her winter port. The Dominion is now the owner of the Canadian Northern, receiver for the Grand Trunk Pacific, and steps have been taken for the acquisition of the Grand Trunk Railway. Export freight rates from the Canadian West via Montreal are now considerably lower than via American ports.

IMPORTS FOR CONSUMPTION.

It is apparent that the trade routes are an important factor in Canadian marketing. If a considerable part of the Canadian wheat must move in bond through the deficiency sections of the East, for export, slight changes in our domestic trade may enable the Dominion to supply a large portion of our domestic requirements.

TABLE 16.—*Imports of wheat and wheat flour into the United States and Canada, 1902–1920.*

[Figures are from Canada Year Book and United States Commerce and Navigation. Canada figures are imports for consumption, fiscal years ending Mar. 31; United States figures are general imports (fiscal years ending June 30), reexports being shown in the last two columns.]

Year.	Imports into Canada.		Imports into the United States.						Reexports from United States (exclusive of shipments in bond as given in Table 14).	
			Wheat.				Wheat flour.			
	Wheat.	Wheat flour.	Total.	From Canada.	From Australia.	From Argentina.	Total.	From Canada.	Wheat.	Flour.
	Bushels.	*Barrels.*	*Bushels.*	*Bushels.*	*Bushels.*	*Bushels.*	*Barrels.*	*Barrels.*	*Bushels.*	*Barrels.*
1902	148,326	47,143	118,612	102,435	.....	.....	420	391	44,555	202
1903	84,931	35,247	1,077,424	1,075,895	19	.....	601	510	1,258,408	715
1904	37,171	40,849	6,852	4,173	170	.....	46,851	46,560	6,230	36,118
1905	92,406	42,397	3,102,585	3,099,802	3	.....	40,801	40,728	570,449	3,783
1906	64,927	41,912	57,995	55,138	416	.....	45,314	45,233	32,972	.....
1907	24,755	34,109	375,433	373,153	10	.....	47,702	47,642	592,970	547
1908	90,255	43,365	341,617	338,665	30	.....	39,593	38,661	307,616	58
1909	46,366	38,792	41,082	31,622	831	.....	92,413	92,413	3,772	.....
1910	55,270	31,458	164,201	152,383	.....	.....	144,759	144,759	136,519	31
1911	115,396	60,738	509,439	502,829	8	.....	141,582	141,582	1,361	8
1912	121,841	47,217	2,699,130	2,673,050	2	71	158,777	158,777	872	98
1913	616,395	59,081	798,028	763,589	.....	.....	107,558	107,558	78,690	966
1914	133,370	55,207	1,978,937	1,891,651	.....	.....	89,911	88,911	746,492	1,376
1915	1,870,174	54,705	426,469	370,863	29	.....	64,200	62,494	181,072	1,533
1916	224,399	34,590	5,703,078	5,673,083	105	.....	329,847	329,577	575,471	10,171
1917	85,264	45,393	24,138,817	23,715,293	59,000	300,258	174,704	174,424	53,863	2,241
1918	210,798	35,192	28,177,281	24,690,105	3,475,079	.....	[1] 675,096	455,175	1,053,744	79,505
1919	303,440	5,564	11,121,461	4,737,624	5,371,646	1,006,595	38,040	31,900	498,762	816
1920	92,087	15,801	4,779,764	3,967,949	262,187	501,111	159,056	148,742	94,000	12,148

[1] Flour from Australia, 207,451 barrels.

[24] From Saskatoon, Saskatchewan, the haul to Liverpool via Hudson Bay is nearly 1,200 miles shorter than via Montreal.

Country elevators and markets.—In the first place, American an Canadian railways are by no means equidistant from the borde The Canadian farmer therefore sometimes has a more favorabl location with respect to American markets and transportation facil ties than his own country affords. Likewise the American farmer i sometimes farther removed from an American than from a Canadia shipping point. Here, indeed, has been a cause for some internation wheat trade which neither the former American duty of 25 cents bushel nor the Canadian duty of 12 cents could entirely remove. Grai has moved north and south across the international boundary, fro farmer to shipper or consumer, just as it moves across the boundar line between Kansas and Nebraska. Import duties have greatly r strained international movements of this character.[25]

So far as freight rates alone are concerned, until 1918 they wer practically the same from western Canada to Fort William and Por Arthur, Duluth, and Minneapolis. In the subsequent rate increase however, this equality of rates was not maintained. By Septembe 15, 1920, the freight rate per 100 pounds from the Canadian wes was around 2 cents higher to Duluth and Minneapolis than to For William and Port Arthur. To Montreal the export rates are 3 cent lower than to New York.

TABLE 17.—*Freight rates (cents per 100 pounds) from the Canadian West t Port Arthur and Fort William, Duluth, and Minneapolis, 1913, 1918, and 1920.*

From—	1913		1918		September, 1920.	
	To—		To—		To—	
	Port Arthur and Fort William.[1]	Duluth, Minneapolis.[2]	Port Arthur and Fort William.[1]	Duluth, Minneapolis.[2]	Port Arthur and Fort William.[1]	Duluth, Minneapolis.[2]
Regina	18	18	24	25	32½	34
Edmonton	25	25	30	33	40½	44½
Calgary	24	24	30	32	40½	43
Saskatoon	22	22	28	30	38	40½

[1] Quoted by the Canadian Railway Commission.
[2] Quoted by the Interstate Commerce Commission.
[25] During the war the Canadian Wheat Board first permitted shipment by wagon across the border without license, but this movement assumed such dimensions, because of the premium on hard wheat in the American markets, that it was prohibited.

TABLE 18.—*Export rates (cents per 100 pounds) [illegible] September 15, 1920.*

From—	To—					
	Montreal.		New York.		Portland [illegible]	
	Lake and rail.	All rail.	Lake and rail.	All rail.	Lake and rail.	All rail.
Fort William and Port Arthur	36½	42	39½	45½	45½	[illegible]
Minneapolis	.....	.....	43	45½	.....	.....
Kansas City	.....	.....	.....	52½	.....	.....

TABLE 19.—*Annual average freight rates on wheat per bushel from Chicago, New York, New York to Liverpool, and Montreal to Liverpool.*

Year.	Chicago to New York.			[illegible]	
	By lake and canal.[2]	By lake and rail.	By all rail.	[illegible]	
	Cents.	*Cents.*	*Cents.*	[illegible]	
1905	6.03	6.35	7.80	[illegible]	
1906	6.65	7.09	7.80	[illegible]	
1907	6.05	6.60	7.80	[illegible]	
1908	5.24	6.49	7.80	[illegible]	
1909	4.92	6.57	7.80	[illegible]	
1910	5.25	5.36	7.80	[illegible]	
1911	5.37	6.54	7.80	[illegible]	
1912	5.99	6.86	7.80	[illegible]	
1913	5.31	6.54	7.80	[illegible]	
1914	6.06	7.47	8.20	[illegible]	
1915	7.96	9.13	8.22	[illegible]	
1916	8.53	9.81	9.01	[illegible]	
1917	12.50	12.50	11.91	[illegible]	
1918	10.70	11.60	13.65	[illegible]	
1919	[5]	17.1	19.2	[illegible]	

[1] Annual report, Board of Trade, Chicago, 1918, p. 100.
[2] Exclusive of Buffalo charges.
[3] Annual statistical report of the New York Produce Exchange, 1918, p. 72.
[4] The Canada Year Book, 1915, pp. 202–203.
[5] No rates available.

American shortages of hard wheats; Canadian requirements of soft varieties.—In the second place, wheat has been imported from one country to the other in response to the demand for particular kinds. Substantially all the wheat of western Canada, which constitutes over 90 per cent of the total Canadian production, is of the hard spring class; in consequence, the manufacturers of biscuits, crackers, and pastry in western Canada find it necessary to bring soft wheats from Ontario or from the United States for such uses or for blending purposes. During the war period of restricted imports soft wheats were shipped all the way from Ontario to the Canadian Pacific region in spite of the fact that abundant supplies were available in Washington.[26] Imports for consumption from the

[26] Northwestern Miller, February, 1920.

United States have been small, however, in comparison with the Canadian shipments southward. South of the border there are frequent shortages of hard wheat, especially of the higher grades of spring wheat, either for milling or for seed. Minneapolis mills have been compelled to draw large quantities from the hard winter wheat regions to the south. It has been seen that not only does the Canadian crop of hard spring wheat now usually exceed that of the United States, but a larger portion of the crop consists of the higher grades especially desired for blending purposes. The large American spring-wheat mills, having an established reputation for the quality of their products and enjoying a wide patronage for particular brands of flour, are naturally loath to vary their individual standards of blending. And owing to the economies attending capacity operation, and to such special features of the American flour trade as have already been noted (see p. 50), they can afford to bid up the price, when necessary, for the kind of grain that will enable them to fill contracts for flour of standard grade. Such activities on the part of the large millers are very likely to result in the importation of Canadian grain.

Temporary surplus in Canada as compared with the demands of the United Kingdom.—Another fact of importance in stimulating shipments to the United States is the annual surplus of Canadian wheat as compared with the demands of the United Kingdom. In November and December there are delivered at Fort William and Port Arthur a greater amount than the United Kingdom, the chief consumer, will normally purchase.[27] The result of this surplus is a fall in price at Winnipeg during the glut. Under such conditions there is, of course, a strong tendency to ship south of the border, especially pronounced in view of the wider American domestic and export market and of the premium which frequently obtains in the great milling centers for "spot" stocks.[28]

Movement of Canadian soft wheats to the East.—So far as concerns comparative rail rates, the Canadian spring wheats are at a distinct disadvantage in shipping to the south; and to the eastern mar-

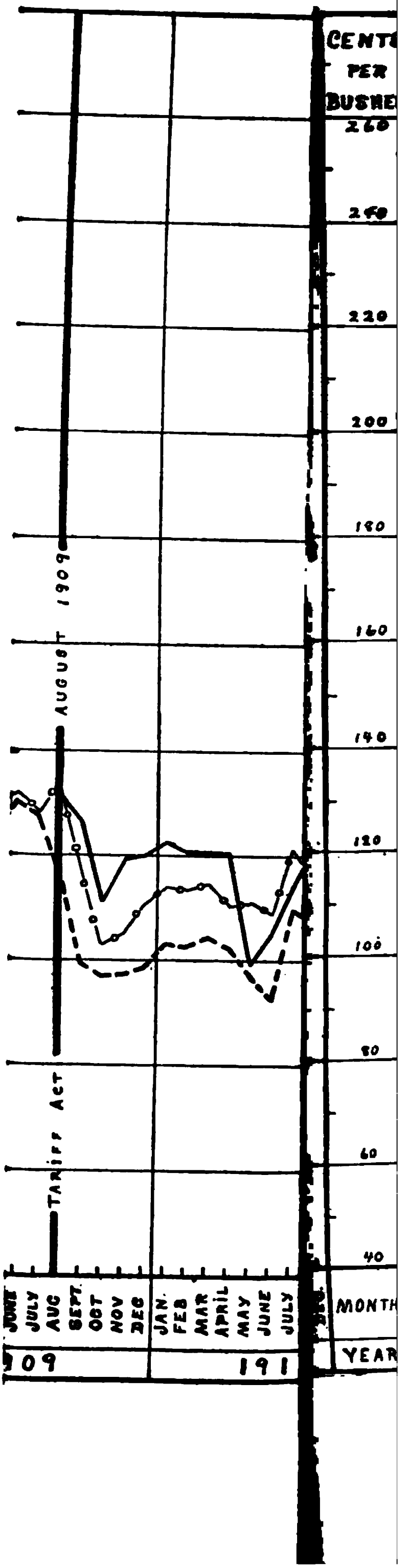
---

[27] Sessional Papers, 19 B, 1916, Parliament of Canada.

[28] "An inquirer can not help raising the question whether Canada has not lost heavily by her method of selling grain. Crop estimates of an optimistic character, the publication of large amounts daily inspected, the advertising of the financial difficulties of the moment, the method of trading wheat, which is almost that of public auction, and the concentration of all the energies of the country upon the rapid marketing of the crop, are conditions that must 'bear' the market. What prices would a merchant obtain for his stock if he (1) proclaimed that his financial position compels him to sell immediately, (2) advises that he had an enormous amount of it on hand, and (3) put his stock up to public auction? * * * In 1913 the Russian Government made provision for enabling the Russian grain to be held back while the torrent from Canada poured into the market."—Canada Grain Commissioners' Report, 1914, p. 86.

T 1.—COMPARATIVE PRICI

(Wholesale prices, cash,



E PRIC
es, cash

hey have a somewhat longer haul than the American hard
The geographical situation slightly favors the sending of
spring wheat to the Pacific Northwest in years of local
f hard wheat. Of much greater importance is the fact
oft-wheat producing sections of eastern Canada enjoy, in
tes to the north Atlantic seaboard, a material advantage
ois and other domestic regions of large production. On
r 15, 1920, for instance, the domestic rate from Toronto to
as 21.0 cents per bushel, from Chicago 27.9 cents. It is
or the eastern Provinces greatly to increase their production
heats and supply a large portion of the requirements for
ieties in the eastern States.

al and concluding factor in the wheat trade between the two
is the duty on imports prior to 1917 and its effect on prices
countries.

COMPARATIVE WHEAT PRICES.

ral factors.—In view of the superior productivity of Canada's
lands and the fact that her export trade has gradually en-
d upon the trade formerly enjoyed by the United States, a
ison of wheat prices in the two countries should throw some
n the question as to whether or not the duties on wheat have
any real benefit to the American farmer; whether they have
d him to secure a higher price for his product than the
ian farmer receives, or whether the price of American wheat
d in the international market independently of American im-
uties. As indicated above, a duty of 25 cents per bushel was
t for about 16 years prior to the act of 1913. After October
3, wheat was free, except from countries imposing a duty on
ican wheat, in which case it was 10 cents per bushel. Inas-
as Canada had a duty of 12 cents, to all intents and purposes
ty was reduced from 25 cents to 10 cents per bushel. In April,
under the authority of the war-measures act, Canada removed
ty on wheat and thereby automatically abolished our duty.

s ordinarily supposed that the duty on wheat is meaningless
e we are an exporting country, and it is the price received for
rplus which, broadly stated, tends to regulate the farm prices
entire crop. But the foregoing analysis of the forces bearing
the situation throws doubt upon the matter. An explanation
facts in the case is attempted in Chart 1 (facing page 61) of
ices of No. 1 Northern wheat in Minneapolis, and of Manitoba
Northern in Liverpool and in Winnipeg (for wheat in store at
William and Port Arthur). These grades are selected because

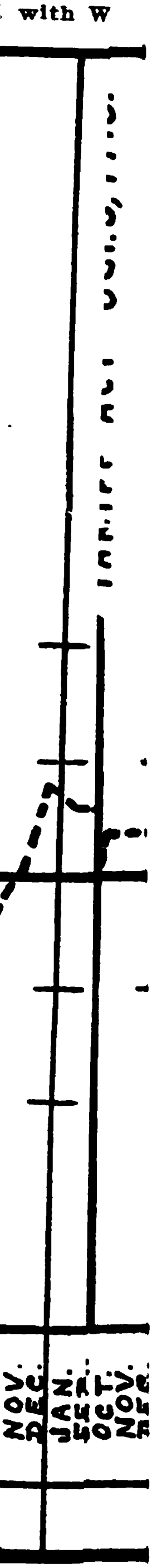
they were the contract grades and are more nearly compa
any other kinds quoted in the four markets. The price c
was not carried beyond 1916 because of the influence of t
sulting in Government fixed prices and abnormal trade

Minneapolis and Winnipeg reflect Liverpool prices.—
standing feature of the chart is that not only Winnipeg h
apolis also follows in general the Liverpool prices.[20] Wi
flects them with great fidelity, the spread being most mark
the winter for reasons discussed above; i. e., the great sur
pared with the Liverpool demands, and the higher tran
charges during the closed winter season. Minneapolis i
pendent upon Liverpool than Winnipeg, and within limit
to other causes. Contrary to some current opinion, howeve
to be influenced by practically the same forces—for the
curves are almost coincident, more nearly so than the ge
and economic factors would lead one to infer.

Higher prices in American markets.—The last and mai
which attention is called is that the Winnipeg price was co
lower than the Minneapolis price (see Chart 2 facing t
From 1906 to October, 1913, when an import duty of 25
bushel was in force in the United States, Minneapolis price
general from 6 to 10 cents per bushel higher; and subsequen
the American duty was reduced to 10 cents per bushel,
spread between the two markets was greatly reduced (see T
The actual disparity in favor of the American market was
higher, since, owing to differences in grading during thi
Manitoba No. 1 Northern was, in the judgment of mille
about 5 cents per bushel more than Minnesota No. 1 North
Canada consumes only about one-third of her crop and s
90 per cent of her exports was shipped to England, Winn
been virtually a purchasing station for Liverpool, and
prices were always on an export basis. Minneapolis is a grea
market as well as a distributing center; in Winnipeg the v
"spot" trading is relatively small. The stronger positio
American industry, due to an enormous domestic consumpti
peting routes, wider foreign markets, and higher prices for
products of milling; the fact that the present position of gr
respect to the milling demand greatly affects its price—the
tive force of such factors have kept prices in Minneapolis we
the Winnipeg level, even when both markets were upon an
basis. The price disparity has varied greatly, being most pro
in the years when there was a short American crop of hard wh

[20] The price curve of No. 1 Northern in Chicago and in the Eastern market
regularly that of Minneapolis, the difference between these markets being d
by freight rates.

1906–191(20.
with W



EFFECT OF IMPORT DUTIES.

In view, therefore, of the facts, (1) that freight rates from Western Canada were the same to Fort William and Port Arthur [30] as to Minneapolis and Duluth and are now only about 2 cents per bushel higher; (2) that the rates from the Canadian markets to Buffalo and the Atlantic seaboard are slightly lower than from Minneapolis; (3) that the transportation routes are already so organized that most of the Canadian wheat ordinarily passes through American ports in bond; and, finally, (4) that some wheat was imported each year in the face of the 25-cent and 10-cent duty—in view of all these facts, it seems inevitable that a lower price in Canada will cause larger amounts of Canadian wheat to be marketed in this country under free trade and normal conditions. Equalization of prices in these markets should be the result.

To what extent the American price would fall is an open question. The answer depends upon complex forces, an important factor of which is the relation of the Canadian surplus to the size of the American market. So long as prices in both countries are on an export basis, and the lower prices in Canada are caused largely by unfavorable conditions of distribution, the improvement of these conditions should result in equalizing Canadian prices without materially affecting those south of the border. If the imports should be relatively small compared with the whole consumption of this country, then the Canadian price would rise almost to the extent of the reduction in duty and the price to the American farmer would fall but little; i. e., Canadian farmers would be greatly benefited by the removal of the duty, American farmers would be but little injured, and the American consumer but little benefited.

Offsetting this view of the case, however, is the difficult question of the elasticity of the demand for wheat. Inasmuch as in normal times the average consumer would use little more wheat bread, no matter how cheap the price, it follows that a small increase in the supply of wheat might not be marketed without a great fall in the price.

A further question of considerable importance is that of the relation between the price of hard and soft wheat; of the effect of the pressure of Canadian hard spring wheats upon the soft-wheat production and markets of the South. Evidently the hard-wheat areas of the United States east of the Rockies would be most directly affected by heavy importations of Canadian wheat, but indirectly

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[30] Winnipeg quotations are for wheat in store at Fort William and Port Arthur, on the lake front.

the price of eastern and southern soft wheats would be affected also. It has been seen that soft wheat has a more limited market than the hard varieties, and that apart from its use in blending and in the breadstuffs to which it is better adapted it has a special market in the South. A larger supply of hard spring wheats may result in what happens in years when an unusually large domestic crop of such wheat is harvested—the great spring-wheat mills enabled to run at full capacity, with reduced cost of operation, would invade the territory of the hard and soft winter wheats in the South and Southeast.

Another point which may be given brief mention is the effect of geographical conditions. As to the Pacific States, which look to foreign markets rather than to the United States for an outlet for their surplus, free trade with western Canada provides another market for their soft wheats. With respect to other domestic markets for soft wheat, reference has already been made to the relatively small production of such wheat in the eastern Provinces. As these Provinces have an advantage in freight rates, especially to the New England markets, it is not improbable that the removal of the tariff barriers will stimulate production and exports. But the hard spring wheat area might feel the effect of Canadian importations more than the soft-wheat sections, not only because of the former's proximity to the Canadian fields but more especially because of the coincidence that the great soft-wheat areas east of the Mississippi have a protection by way of freight differentials. The eastern section of the country is a deficiency region; i. e., it consumes more wheat than it produces, and the farmers in this region get the benefit of the freight eastward from the western markets. Thus, ordinarily the lowest prices are paid to wheat producers in central Idaho; prices graduate upward to the west, east, and south of this region, the highest levels being reached in the Southeast, which is most distant from the important surplus-producing areas.[5] However, because of offsetting expenses that may equalize conditions in the two sections, it should not be concluded that the eastern farmer necessarily receives a larger profit per bushel than the western producer.

TABLE 20.—*Cash wheat prices*[1] *in Minneapolis, Winnipeg, and Liverpool, 1906–1916. (No. 1 Northern in Minneapolis, Manitoba No. 1 Northern in Winnipeg (for wheat in store at Fort William or Port Arthur) and Manitoba No. 1 Northern, or No. 1 Northern in Liverpool. Figures are averages, by months, of the quotations on or about the first market day of each week.)*

(Before and after the reduction in the American import duty, tariff act of Oct. 3, 1913.)

	January.	February.	March.	April.	May.	June.
1907—Liverpool	$0.942	$0.961	$0.957	$1.009	$1.061	$1.054
Winnipeg	.726	.748	.747	.765	.863	.884
Minneapolis	.799	.825	.799	.818	.954	1.003
1908—Liverpool	1.248	1.249	1.264	1.245	1.261	1.207
Winnipeg	1.079	1.061	1.099	1.054	1.119	1.046
Minneapolis	1.106	1.053	1.084	1.032	1.081	1.085
1909—Liverpool	1.202	1.248	1.337	1.375	1.396	1.396
Winnipeg	.992	1.055	1.108	1.176	1.245	1.304
Minneapolis	1.091	1.116	1.155	1.229	1.307	1.322
1910—Liverpool	1.231	1.213	1.209	1.208	.995	1.052
Winnipeg	1.034	1.025	1.044	1.023	.977	.931
Minneapolis	1.141	1.136	1.146	1.105	1.111	1.092
1911—Liverpool	1.121	1.126	1.106	1.086	1.092	1.091
Winnipeg	.943	.918	.892	.895	.943	.96
Minneapolis	1.069	1.006	.977	.958	.988	.969
1912—Liverpool	1.237	1.265	1.235	.....	.....	1.211
Winnipeg	.953	.97	.976	1.017	1.038	1.056
Minneapolis	1.067	1.061	1.068	1.079	1.152	1.141
1913—Liverpool	1.133	1.144	1.101	1.145	1.168	1.142
Winnipeg	.821	.835	.851	.886	.929	.962
Minneapolis	.85	.868	.85	.869	.904	.918
1914—Liverpool	1.046	1.072	1.074	1.067	1.099	1.078
Winnipeg	.853	.885	.903	.899	.94	.928
Minneapolis	.876	.923	.927	.912	.938	.913
1915—Liverpool	1.725	1.998	2.00	1.991	2.136	1.837
Winnipeg	1.334	1.533	1.486	1.571	1.569	1.25
Minneapolis	1.353	1.514	1.472	1.541	1.577	1.287
1916—Liverpool	2.021	2.143	2.065	1.935	1.857	1.607
Winnipeg	1.203	1.185	1.096	1.15	1.165	1.102
Minneapolis	1.289	1.283	1.141	1.217	1.215	1.114

	July.	August.	September.	October.	November.	December.
1906—Liverpool	.....	.....	$0.922	$0.942	$0.932	$0.933
Winnipeg	.....	.....	.723	.749	.753	.744
Minneapolis	.....	.....	.742	.759	.80	.794
1907—Liverpool	$1.076	$1.061	1.106	1.238	1.292	1.282
Winnipeg	.921	.904	1.014	1.101	1.021	1.03
Minneapolis	1.014	.995	1.082	1.083	1.039	1.058
1908—Liverpool	1.201	1.265	1.267	1.219	1.19	1.184
Winnipeg	1.058	1.075	.997	.983	1.019	.991
Minneapolis	1.119	1.154	1.028	1.031	1.067	1.093
1909—Liverpool	.....	1.32	1.269	1.115	1.186	1.205
Winnipeg	1.286	1.175	.995	.972	.979	.987
Minneapolis	1.288	1.344	.997	1.033	1.053	1.108
1910—Liverpool	1.141	1.234	1.218	1.089	1.094	1.083
Winnipeg	1.099	1.079	1.019	.965	.919	.901
Minneapolis	1.215	1.149	1.113	1.071	1.035	1.026
1911—Liverpool	1.107	1.154	1.186	1.221	1.145	1.162
Winnipeg	.957	.976	1.008	.997	.991	.961
Minneapolis	.979	1.028	1.038	1.092	1.063	1.021
1912—Liverpool	1.189	1.202	1.247	1.205	1.097	1.103
Winnipeg	1.073	1.06	1.014	.911	.853	.79
Minneapolis	1.091	1.03	.904	.893	.857	.831
1913—Liverpool	1.141	1.13	1.115	.973	.966	1.034
Winnipeg	.971	.953	.919	.817	.824	.837
Minneapolis	.911	.884	.878	.841	.842	.859
1914—Liverpool	1.074	1.269	1.395	1.358	1.366	1.535
Winnipeg	.903	1.059	1.112	1.125	1.185	1.191
Minneapolis	.897	1.068	1.136	1.102	1.159	1.192
1915—Liverpool	1.725	1.781	1.77	1.769	1.792	1.811
Winnipeg	1.352	1.194	.937	.968	1.031	1.119
Minneapolis	1.39	1.373	.981	1.011	1.018	1.131
1916—Liverpool	1.635	2.076	2.171	2.293	2.502	2.652
Winnipeg	1.185	1.487	1.606	1.738	1.959	1.758
Minneapolis	1.17	1.485	1.608	1.757	1.93	1.761

[1] Liverpool prices were compiled from weekly quotations in Broomhall's Corn Trade News; Winnipeg prices, 1906–1913, from Northwestern Miller; 1914–1916, from Wholesale Prices, Canada; and Minneapolis prices, from the Northwestern Miller, 1906–1913; 1914–1916 from "Wholesale Prices," U. S. Department of Labor.

OATS AND OATMEAL.

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OATS AND OATMEAL.

SUMMARY AND CONCLUSIONS.

While the great bulk of the world crop of oats is consumed locally in feeding live stock, the competitive surplus of exporting countries may be either expanded or contracted, and the volume of shipments will depend upon the price and supply of substitute feed-stuffs as well as of oats, upon the magnitude of the live-stock industries, and upon prices of live stock. Less than 5 per cent of the world production enters into international trade.

Between the years 1890 and 1915 the American oat production had trebled. Since then the oat acreage has increased but slightly. Great as has been this increase in production, it has not kept pace with the growing requirements of the domestic market. Exports had declined from around 40,000,000 bushels annually during 1896–1900 to around 2,000,000 bushels in the years immediately preceding the World War. Imports, though variable and still relatively small, are increasing. In 1914 and 1920 they amounted to 22,000,000 and 6,000,000 bushels, respectively, valued at about $8,000,000 and $6,000,000. Imports are almost exclusively from Canada.

Production has been increasing more rapidly in Canada than in the United States, and the area of additional land available for settlement and oat cultivation in Canada is much larger than in this country.

On account of the superior climate of Canada for oat production and the abundance of fresh fertile land, the quality of the grain is better on the whole than the quality of the American product, and yields to the acre are larger.

In costs of production per bushel of oats—so far as such costs may be measured by the data available—little or no advantage may be discerned in favor of either country. Lower yields to the acre and higher charges for land rental or interest in the States virtually balance the higher direct costs of production and higher costs per acre in the Dominion.

If long-run costs be considered, the difference is distinctly in favor of the growers in the important oat-producing regions of the United States in a comparison with the western grain-growing Provinces of Canada, and to a lesser degree in a comparison with the eastern Provinces. Chief among the disadvantages of the western Provinces are (1) the periodical loss of revenue incident to the practice of

summer fallowing, a practice which is deemed essential in some of the producing sections; and (2) greater distance to markets, with the consequent higher costs of transportation. Other factors of comparative advantage in the States are the saving incident to the usual practice of sowing grass seed with oats, and the higher value and greater use made of oat straw.

While farm consumption ordinarily absorbs about 70 per cent of the domestic crop, the marketable surplus is extremely elastic, because of the availability of large crops of substitute feedstuffs, and the close relation to conditions in the live-stock industries. Normally the domestic trade in this product exceeds in volume the international trade.

Foreign competition especially affects oat growers in the great live-stock producing section in the North Central States. This section produces three-fourths, and consumes nearly one-half, of the national production. It ships most of the oats that enter the general channels of trade, and the markets for this surplus lie to the east and south, for city and farm consumption. The oats of the Pacific States usually enter into a trade apart from that of the rest of the country; foreign competition is not a factor in Pacific coast markets.

In the East and South, which are regions of deficient production, local producers have some protection in the costs of transportation from the surplus-producing regions. While the prices paid to growers are lowest in the western part of the surplus-producing States, that is, in Minnesota and North Dakota, they rise steadily from this region toward the eastern ports, and more notably toward the south and west. Prices are highest in the Southeast and Southwest, frequently higher than in the world markets.

In competition with the western grain-growing Provinces of Canada for eastern and southern markets, the growers of the North Central States have a permanent advantage in geographical proximity. Ontario and the eastern Provinces are better situated with regard to the eastern markets. In competition for the farm demand, the difference between farm and market values greatly favors the local producer.

The Canadian import duty of 10 cents a bushel and the American duties of 15 cents (act of 1897) and 6 cents (act of Oct. 3, 1913) have not entirely prevented the movement of oats across the boundary line. Both countries have imported, but the United States has imported far more than Canada.

Exports of oats and oatmeal from Canada, while not large, have regularly exceeded imports and have been increasing in amount, whereas exports from the United States reached their highest figure toward the end of the last century; since that time—until the out-

break of the war—exports have been declining, and oat imports have frequently exceeded exports. Exports have been large only in large crop years.

The duties on oat imports constituted only one, and probably not the most important, of the factors that contributed to the decline in the exports of American oatmeal.

The Canadian import duty of 10 cents has had no appreciable effect upon the Canadian price of oats. For the most part that price has been adjusted with reference to the price in Liverpool.

In the years when American exports were large, the Buffalo price—which may fairly be regarded as typical of American prices—has also been adjusted with reference to the price in Liverpool; but for the greater portion of the period 1906 to 1916 the American price was well above the Canadian price, and in some years it was considerably above the price in Liverpool.

The reason for the excess of the Buffalo over the Toronto prices is to be found partly in the geographic situation with regard to the oat markets in the South and East, and partly in the American import duty. The duty on oats has been most marked as a cause for the spread between the quotations of the two markets in years when American production declined or in years when record crops were harvested in Canada. In the period 1906 to 1916 there were several such years.

Finally, so far as the immediate crops in question are concerned, the general effect of the duty on oats has been to keep down the price received by the Canadian farmer, with little or no corresponding benefit to the American producer, and principally to the advantage of the Canadian transportation interests. These conclusions are based upon the consideration that, while the Canadian surplus for export has normally been around 5 million bushels, the American consumption has easily absorbed differences in harvest from year to year of as much as 500 million bushels, the quantity ordinarily shipped to markets being between 300 and 400 million bushels. In so large and elastic a market the entry of a few million bushels of Canadian oats could have little effect upon the general level of prices. A local effect might be felt, as, for instance, in the deficiency sections of New York State which adjoin the surplus-producing regions of Ontario. It also appears that in the years of large export across the border the loss to the Canadian grower was greater when the duty was 15 cents then when it was 6 cents. Canadian prices are on an export basis—Liverpool prices less transportation; prices in the protected American markets may oscillate from an export basis to the Liverpool prices plus transportation, and the advantage of the American markets is more pronounced when the domestic crop is short or poor in quality.

The principal beneficiaries of the former rate of 15 cents per bushel appear to have been the carrying and grain-distributing interests of Canada—of eastern Canada in particular. The customs revenue received through this duty was usually unimportant, for the 15-cent rate was virtually prohibitive, and the Canadian product was compelled to take the long route eastward and across the Atlantic. Complete freedom of trade would have given it access to the important markets across the border, which could be reached more cheaply than those of Europe; it would also have permitted the American grain interests and primary markets to compete for this business. Whether the present import duty of 6 cents a bushel is a more competitive rate remains yet to be seen when normal conditions of trade are restored; present indications point to a larger volume of exports to the States. While a record export to the United States occurred during the months following the reduction of the duty, subsequent war demands absorbed Canada's surplus. In the fiscal year 1920 imports again rose to about 6,000,000 bushels, valued at $6,000,000.

TARIFF SITUATION WITH RESPECT TO OATS.

From 1897 until the enactment of the tariff act now in force—that of October 3, 1913—the American import duty upon oats was maintained at 15 cents per bushel, and upon oatmeal at 1 cent per pound.[1] The present rate upon oats is 6 cents per bushel, and upon oatmeal 30 cents per 100 pounds. Nearly all imports are from Canada, which imposes a duty of 10 cents per bushel upon American oats and 60 cents per 100 pounds upon oatmeal.

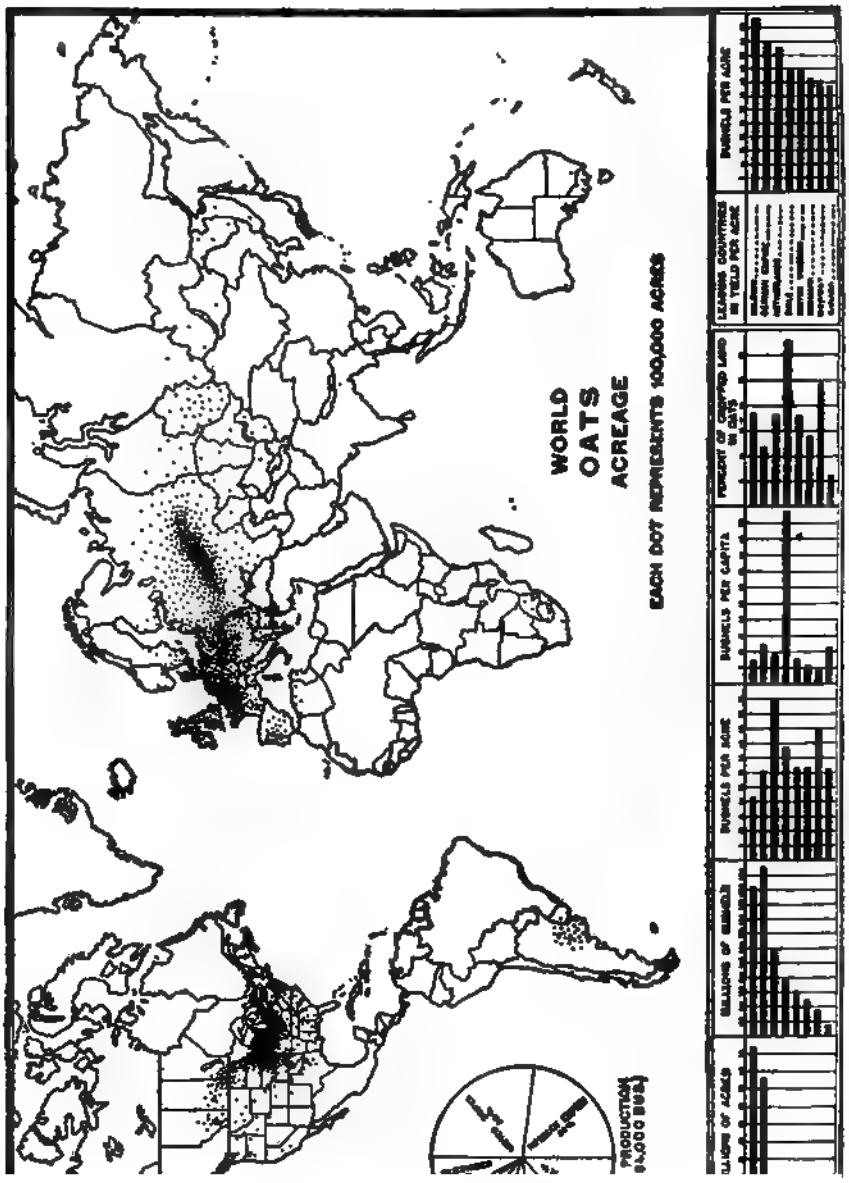
Imports duties of the United States, upon oats, oatmeal, rolled oats, oat hulls, 1883 to 1913.

Tariff act.		Tariff classification or description.	Rate of duty.
Year.	Paragraph.		
1883	264	Oats	10 cents per bushel.
	266	Oatmeal	½ cent per pound.
1890	259	Oats	15 cents per bushel.
	260	Oatmeal	1 cent per pound.
1894	190	Oats	20 per centum ad valorem.
		Oatmeal	15 per centum ad valorem.
1897	230	Oats	15 cents per bushel.
	231	Oatmeal and rolled oats	1 cent per pound.
		Oat hulls	10 cents per 100 pounds.
1909	238	Oats	15 cents per bushel.
		Oatmeal and rolled oats	1 cent per pound.
		Oat hulls	10 cents per 100 pounds.
1913	192	Oats	6 cents per bushel of 32 pounds.
		Oatmeal and rolled oats	30 cents per 100 pounds.
		Oat hulls	8 cents per 100 pounds.

WORLD PRODUCTION AND TRADE.

Oats are grown mostly in cooler and more humid climates than are wheat and barley; and it is a hardy, short season crop which may be grown on a wide variety of soils. The three principal producing regions are the north central and northeastern parts of the United States and the adjoining Provinces of Canada, northwestern Europe, and Russia. In 1913—the latest year for which comparable statistics are available—the United States ranked first among the producing countries with about 24 per cent of the world crop. Russia followed closely and Germany ranked third with 14 per cent. The oat crop is of greatest local importance in Canada, if measured by the percentage of the cropped land in oats or by the per capita production.

[1] One bushel of oats (32 pounds) will produce approximately 18 pounds of oatmeal.



MAP 1.—WORLD ACREAGE IN OATS. (From Yearbook, 1914, U. S. Department of Agriculture.)

Although the world production—around 4½ billion bushels—is considerably in excess of the wheat production, only around 165,000,000 bushels [2] normally enter into international trade—about one-fourth of the foreign trade in wheat. A comparatively small fraction of the total production is used for human food, less of it, proportionately, for this purpose in the United States than in Canada or in Europe. The great bulk of the crop is fed on the farms where it is grown. It is primarily a feedstuff, used in connection, and to some extent interchangeably, with other feeds; consequently the competitive surpluses of exporting countries may be greatly expanded or contracted, according to the price of oats, the price and availability of other feedstuffs, and to a certain extent the prices of live stock.

Channels of trade, and the principal competitors of the United States in the international markets, are indicated in Table 1. Prior to the World War the net exports consisted almost exclusively of the surplus of five countries—Russia, Argentina, Canada, Roumania, and the United Kingdom. Nearly all of this surplus moved to Central and Western Europe, chiefly to the United States, France, Switzerland, and Germany; and of the shipments to Europe the Americas contributed approximately 45 per cent during the years 1911–1913.

TABLE 1.—*International Trade in Oats.*[1]

[Figures are averages for the three years 1911–1913, and represent net exports and imports.]

[In thousands of bushels.]

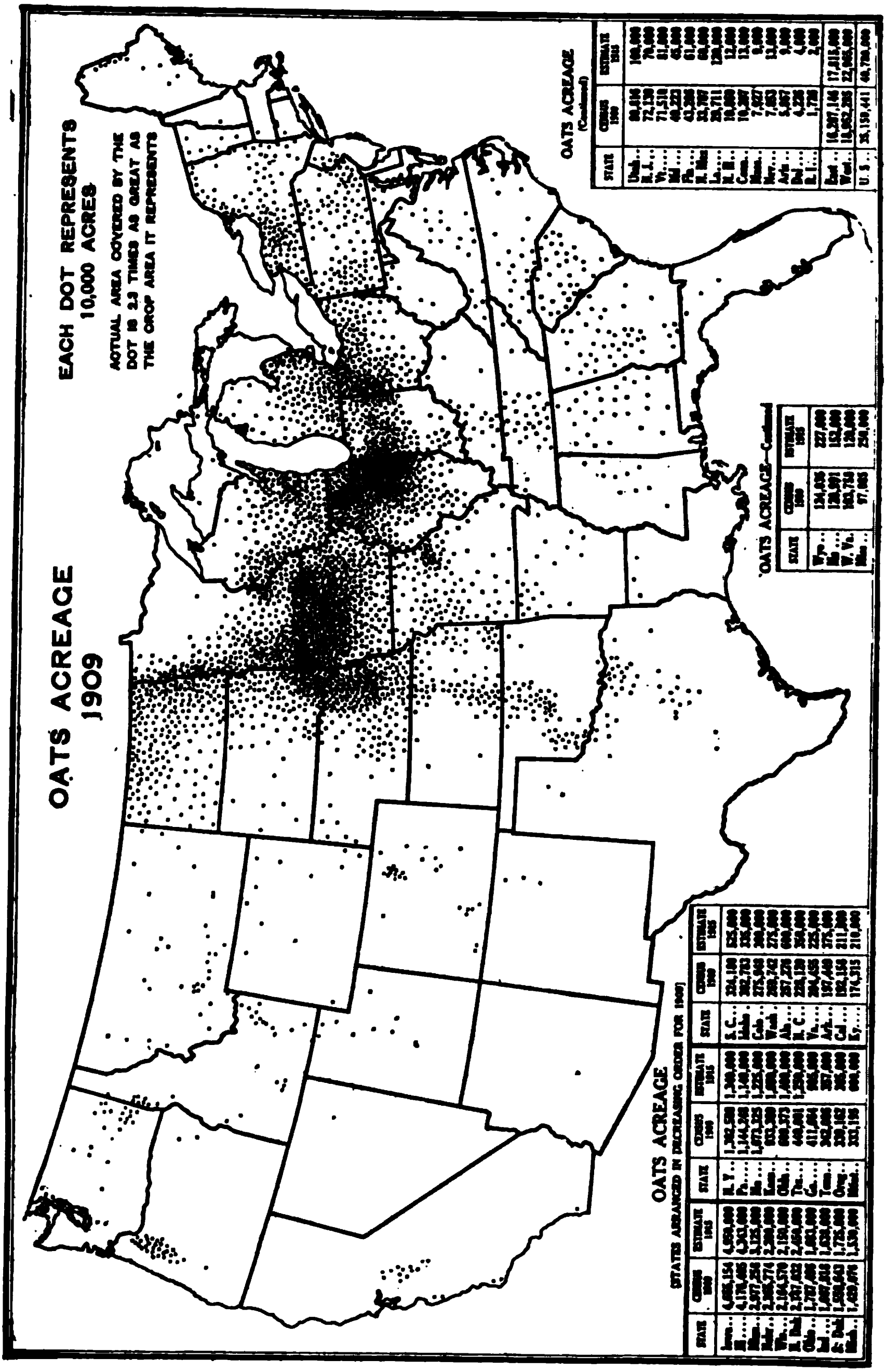
Exports to—		Imports into—	
All countries	165,583	United Kingdom	63,344
Principal countries:		France	30,746
Russia	63,636	Switzerland	12,484
Argentina	52,754	Germany	10,476
Canada	16,583	Belgium	8,845
Roumania	10,012	Italy	9,040
United States	7,035	Netherlands	8,087

[1] Compiled from Yearbooks, U. S. Department of Agriculture. Includes relatively small quantities of oatmeal, equated to oats.

PRODUCTION IN THE UNITED STATES.

Producing sections.—In 1870 the oat crop of the United States was 247,277,000 bushels; in 1890 it was 523,621,000 bushels; and in 1900 it amounted to 809,126,000 bushels. Until 1910 European Russia usually led the world in oat production, but since that year the United States has produced a greater quantity than any other nation. In 1917, on an area of 43,553,000 acres, the American production amounted to 1,592,740,000 bushels, the largest crop on record.

[2] Net exports. The world production of oats exceeds that of wheat in bulk, but not in weight.



MAP 2.—GEOGRAPHIC DISTRIBUTION OF OATS ACREAGE IN THE UNITED STATES.
(From Yearbook, 1915, U. S. Department of Agriculture.)

While this plant is the most widely distributed of the American cereals, the great oat-producing section lies in the North Central division—the world's greatest grain and live-stock producing region. Approximately 75 per cent of the country's yearly crop is now produced in this division—as compared to about 25 per cent in 1870; and about one-third of the total is contributed by Iowa, Illinois, and Minnesota. For a number of years these three States have outranked all others in both acreage and production. While oat production has increased throughout the United States, this increase has been especially marked in the North Central States west of the Mississippi, whose crop rose from an annual average of 58 million bushels during 1871–1875 to 528 million bushels during 1911–1915. Until recently the only important oat-producing States outside of the North Central division were New York and Pennsylvania, but now Oklahoma, Montana, and Texas are also to be included. It is to be noted, however, that since 1900 there has been a very great increase in production in the Mountain States, in the Pacific Northwest, and in the South—a fivefold increase in some States between 1900 and 1915; but the production of these regions is as yet relatively unimportant.

The production and commercial movement of oats, by States and geographic divisions, are shown in Table 2.

TABLE 2.—*Production and commercial movement of oats, by States and geographic divisions.*

[From Bul. 755, U. S. Department of Agriculture; five-year averages, 1911–1915.]

State and geographic division.	Production.			Shipped out of counties where grown.		
	Quantity.	Per cent of United States production.	Per capita.	Quantity.	Per cent of production of State or division.	Per cent of total shipments.
	Thousand bushels.		*Bushels.*	*Thousand bushels.*		
United States	1,228,765	100.0	12.6	360,560	29	100.0
New England	9,789	.8	1.4	149	2	(1)
Middle Atlantic	80,401	6.5	3.9	4,930	6	1.4
South Atlantic	32,461	2.6	2.5	1,385	4	.4
East North Central	395,331	32.2	20.8	144,601	37	40.1
West North Central	527,674	42.9	43.8	157,009	30	43.5
East South Central	21,558	1.8	2.5	1,856	9	.5
West South Central	60,946	5.0	6.4	15,813	26	4.4
Mountain	65,282	5.3	22.2	20,442	31	5.7
Pacific	35,323	2.9	7.4	14,375	41	4.0
New England:						
Maine	5,452	.4	7.2	112	2	(1)
New Hampshire	441	(1)	1.0	4	1	(1)
Vermont	3,178	.3	8.8	32	1	(1)
Massachusetts	305	(1)	.1	1	(1)	(1)
Rhode Island	58	(1)	.1	.....	.....	.....
Connecticut	355	(1)	.3	.....	.....	.....
Middle Atlantic:						
New York	42,500	3.4	4.4	2,331	5	.6
New Jersey	2,024	.2	.7	216	11	.1
Pennsylvania	35,877	2.9	4.4	2,383	7	.7

[1] Less than one-tenth of 1 per cent.

TABLE 2.—*Production and commercial movement of oats, by States and geographic divisions*—Continued.

State and geographic division.	Production.			Shipped out of counties where grown.		
	Quantity.	Per cent of United States production.	Per capita.	Quantity.	Per cent of production of State or division.	Per cent of total shipments.
South Atlantic:	*Thousand bushels.*		*Bushels.*	*Thousand bushels.*		
[illegible]	121	(1)	0.6	12	10	(1)
[illegible]	1,309	0.1	1.0	167	13	0.1
[illegible]	4,106	.3	1.9	295	7	.1
[illegible]	2,774	.2	2.1	80	3	(1)
[illegible]	4,864	.4	2.1	97	2	(1)
[illegible]	7,963	.7	5.1	206	4	.1
[illegible]	10,429	.8	3.8	439	4	.1
[illegible]	868	.1	1.1	19	2	(1)
East [illegible]:						
Ohio	64,308	5.2	13.0	21,868	34	6.0
Indiana	54,731	4.5	19.8	23,801	43	6.6
Illinois	145,982	11.9	24.7	72,156	49	20.0
Michigan	50,948	4.1	17.3	12,411	24	3.4
Wisconsin	79,382	6.5	32.8	14,565	18	4.1
West North Central:						
Minnesota	104,457	8.5	47.9	30,449	29	8.4
Iowa	175,081	14.2	78.8	77,507	44	21.5
Missouri	27,807	2.3	8.3	3,772	14	1.0
North Dakota	73,436	6.0	111.1	13,200	18	3.7
South Dakota	44,507	3.6	69.2	13,992	31	3.9
Nebraska	57,977	4.7	47.0	12,439	21	3.4
Kansas	44,409	3.6	25.2	5,650	13	1.6
East South Central:						
Kentucky	3,893	.3	1.7	172	4	(1)
Tennessee	6,967	.6	3.1	1,313	19	.4
Alabama	7,455	.6	3.3	212	3	.1
Mississippi	3,248	.3	1.7	159	5	(1)
West South Central:						
Louisiana	1,429	.1	.8	166	12	(1)
Texas	29,803	2.5	7.1	10,422	35	2.9
Oklahoma	23,653	1.9	12.2	4,953	21	1.4
Arkansas	6,061	.5	3.7	261	4	.1
Mountain:						
Montana	23,103	1.9	55.1	7,243	31	2.0
Wyoming	8,179	.7	50.2	1,846	23	.5
Colorado	11,567	.9	13.1	3,040	26	.8
New Mexico	1,867	.1	5.0	331	20	.1
Arizona	298	(1)	1.3	37	12	(1)
Utah	4,340	.4	10.7	1,103	25	.3
Nevada	499	(1)	5.3	83	17	(1)
Idaho	15,409	1.3	40.7	6,709	44	1.9
Pacific:						
Washington	14,035	1.1	10.4	6,409	46	1.8
Oregon	14,040	1.2	18.5	4,570	33	1.3
California	7,243	.6	2.7	3,396	47	.9
United States	1,223,765	100.0	12.6	360,560	29	100.0
Exports (including oatmeal)	48,291	3.9				
Imports	5,383	.4				

[1] Less than one-tenth of 1 per cent.

Regional characteristics.—Methods of cultivating oats, and of disposing of the crop, vary considerably throughout the United States. In the great oat-producing region the crop is spring sown, and is, of course, grown for the grain. This is also true of Canada. But in a large part of the South it is fall sown. In California and in many parts of the South oats are frequently cut before maturity for hay—in Tennessee about 50 per cent of the crop is harvested in this manner; and the crop is sometimes pastured or plowed under for green

manure.[a] In the Mountain States a good deal of the crop is grown under irrigation. And some use is made of commercial fertilizer in oat production in the East and South, whereas in Canada and in the chief producing sections of the States little or no commercial fertilizer is used.

In view of the dominance of the northern, and especially of the North Central States in oat production, these differences are of little importance for the purposes of the present comparison. They appear of even less importance when consideration is given the fact that fully 85 to 90 per cent of the commercial oats of the United States originates within the North Central States, and the further fact that virtually all other sections, with the exception of the Pacific Northwest, produce less than their requirements and must import oats from this surplus-producing region. Canadian competition—present or future—is therefore to be considered as especially affecting this north-central section, and conditions in the Canadian Provinces are more nearly comparable to those of these States.

TABLE 3.—*Acreage, production, average yield per acre, and quality of oats in the United States,[a] 1902–1920, and in Canada,[a] 1908–1920.*

Year.	Acreage in oats.		Quantity produced.		Average yield per acre.[b]		Quality, as indicated by average weight per measured bushel.[b]	
	United States.	Canada.	United States.	Canada.	United States.	Canada.	United States.	Canada.
		Acres.	*Bushels.*	*Bushels.*	*Bushels.*	*Bushels.*	*Pounds.*	*Pounds.*
1902	28 00		987,84[illegible] 00		34.5			
1903	27 00		784,09 00		28.4			
1904	27 00		894,59 00		32.1			
1905	28 00		952,21 00		34.0			
1906	30 00		964,90 00		31.2			
1907	31 00		754,44 00		23.7			
1908	33 00	7 00	807,15 00	250,377,000	25.0	31.64	29.8	35.47
1909	36 00	9 00	1,007,14 00	353,466,000	28.6	38.00	32.7	35.65
1910	37 00	8 15	1,136,34 00	243,506,292	31.6	28.14	32.7	36.06
1911	37 00	9 60	922,29 00	365,179,000	24.4	37.92	31.1	34.65
1912	37 00	9 00	1,418,33 00	391,629,000	37.4	39.29	33.0	35.40
1913	38 00	10 00	1,121,76 00	404,669,000	29.2	38.78	32.1	36.48
1914	38 00	10 00	1,141,06 00	313,078,000	29.7	31.12	31.5	35.31
1915	40 00	11 81	1,549,03 00	464,954,400	37.8	40.24	33.0	36.61
1916	41 00	10 87	1,251,83 00	410,211,000	30.1	37.30	31.2	33.86
1917	42 00	13 00	1,592,74 00	403,009,800	36.6	30.25	33.4	33.65
1918	44 00	14 36	1,538,12 00	426,312,600	34.7	28.75	33.2	35.31
1919	43 00	14 14	1,248,31 00	304,387,000	29.4	26.25	33.1	36.01
1920[c]	41 90	16 28	1,441,63 00	543,058,000	35.1	33.3		

[a] Figures for the United States are from Yearbooks of the Department of Agriculture. Figures for Canada are from the Canada Yearbook. Canadian statistics for the period 1902–1907 are not available.

[b] American yields are in Winchester bushels of 32 pounds; Canadian yields are in Imperial bushels of 34 pounds. The weight per bushel is one of the chief indications of quality, other factors being color and freedom from dirt and other grains.

[c] Preliminary estimates.

[d] In California and in nearly all of the cotton States less than one-half of the crop is thrashed, the bulk of it being cut green and cured for hay, pastured, or used for soiling. U. S. Dept. of Agr. Yearbook, 1919, p. 689, Percentage of grain crops harvested by different methods.

PRODUCTION IN CANADA.

Canada has been virtually the sole source of imports. In that country, also, the yearly production of oats has shown a steady increase. In 1870 the total crop was 42,489,000 bushels, in 1900 it amounted to 151,497,000 bushels, and in 1915, which was a record year in Canada, the total production reached 464,954,400 bushels. This represents a proportionally greater increase in production than the increase in the United States during the same period. The acreage in oats has steadily increased, that of 1919 amounting to 14,997,135 acres, nearly twice that of 1908. The acreage, production, and yield per acre since 1908, in both countries, are shown in Table 3.

The chief oat-producing Provinces of Canada are Saskatchewan and Ontario, the two together contributing about one-half of the total Canadian crop. The proportion of the crop grown in the eastern Provinces fell from 90 per cent in 1900 to around 35 per cent in 1917. Until 1915 Ontario was the chief oat-growing Province, but first place has now been taken by Saskatchewan. In Ontario and Quebec production was almost stationary before the war; in the prairie Provinces both the oat-acreage and production have been increasing rapidly. In other Provinces the crop is relatively insignificant. The acreage and production in the Canadian Provinces since 1890 are shown in Table 4.

TABLE 4.—*Acreage and production of oats in Canada, by Provinces, for selected years, 1891–1919.*

[From the Canada Yearbooks and Census and Statistics Monthly.]

ACREAGE.

Province.	1919	1915	1910	1901	1891
Canada	14,997,135	11,555,681	8,652,015	5,367,655	3,961,348
Prince Edward Island	174,237	196,000	181,636	164,472	153,924
Nova Scotia	158,838	112,000	96,177	91,087	94,117
New Brunswick	305,484	201,000	201,140	186,939	157,176
Quebec	2,141,107	1,400,000	1,387,961	1,350,031	1,161,000
Ontario	2,674,341	3,095,000	2,871,288	2,707,357	2,053,105
Manitoba	1,847,267	1,317,365	1,209,173	573,858	256,211
Saskatchewan	4,837,747	3,336,245	1,888,359	141,807	61,637
Alberta	2,767,372	1,827,071	783,072	117,745	
British Columbia	90,042	71,000	33,209	34,366	24,148

PRODUCTION (BUSHELS).

Canada	411,136,000	464,954,000	243,506,292	151,497,407	83,428,202
Prince Edward Island	6,779,000	6,832,500	5,211,588	4,561,097	2,922,552
Nova Scotia	5,798,000	3,487,700	2,973,769	2,347,598	1,559,842
New Brunswick	9,852,000	5,559,600	5,538,796	4,816,173	3,025,329
Quebec	61,022,000	42,183,000	33,734,172	33,536,677	17,818,588
Ontario	76,219,000	122,810,000	82,946,041	88,138,974	47,160,246
Manitoba	64,193,000	50,750,000	30,378,379	10,302,660	8,370,212
Saskatchewan	117,316,000	145,066,000	58,922,791	2,214,616	1,628,344
Alberta	65,725,000	83,876,000	16,099,223	3,781,046	
	32,000	4,390,600	1,701,533	1,442,566	943,088

COMPARATIVE PRODUCTIVITY AND COST.

Comparative yields and quality.—A comparison of the yield of oats per acre in Canada and the United States since 1907 shows a close parallel to the proportionate wheat yields of the two countries during that period.[4] In most years the average yield per acre in Canada is well above the average yield in the United States. For the whole period 1908 to 1919, inclusive, the average oat yield in this country was 31.2 bushels per acre, and in Canada 34.1 bushels. In making these comparisons it should be borne in mind that the actual differences in favor of Canada are larger, since the Canadian yields are reported in Imperial bushels of 34 pounds and those of the United States in Winchester bushels of 32 pounds.[5] Moreover, the Canadian oats are in general of a somewhat better quality. Test weight per bushel, color, and the percentage of dirt, other grains, and wild oats are the chief indications of quality. The average weight (computed in terms of the American Winchester bushel) during 1908–1917 was 34.2 pounds in Canada and 32 pounds in the United States, and the proportion of white oats, which command the highest prices, is probably larger. In Canada and in the principal oat-producing States, excepting Iowa, white oats are generally grown. In Iowa the bulk of the crop consists of yellow oats; in the South of red oats; and in the Pacific States of black and gray oats.

The difference between the two countries in yield per acre and weight per bushel is even greater when a comparison is made between Saskatchewan or Alberta and the three principal oat-producing States, namely, Iowa, Illinois, and Minnesota, in the five-year period 1910 to 1914. (See Tables 5 and 6.) In the two prairie Provinces the average yields were 38.17 and 41.09 bushels, respectively; in the three American States the average yields were 35, 32.58, and 31.78 bushels, respectively. Although the warm summers in the chief oat-producing States are not well adapted to oat production, the grain is extensively grown because it fits into the crop rotation and competes but slightly in labor requirements with corn, the dominant crop. The higher yields in the western Provinces are offset, however, by the periodical loss of the use of the land incident to the general practice of summer fallowing.[6] This loss ranges from every alternate year in the more arid regions to every fifth year in other sections and more than offsets the lower yields per acre in such States as Iowa

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[4] See p. 44.

[5] The Winchester bushel, the official measured bushel of the United States, is equal to 0.9694 of an Imperial bushel, the official measured bushel of Canada.

[6] See p. 84.

or Illinois. In other States and Provinces some exceedingly high yields may be found. The oat yield of British Columbia, for instance, is normally above 50 bushels per acre, while in Washington the average yield for the 10 years 1910–1919 has been 44.5 bushels, and during the same period the yield in Utah and Idaho (to a considerable extent under irrigation) has been 44.4 and 42.5 bushels, respectively. But the total production of these States and of British Columbia is relatively small.

Costs of production.—Estimates of the costs of producing oats in Canada in 1911 and in the United States in 1909, based upon reports from correspondents of the Canadian and American Departments of Agriculture, may be used for purposes of rough comparison. It is probable that in both countries costs have risen proportionately since that time. The various items in cost for each country as a whole and for specified States and Provinces are given in Tables 5 and 6.

TABLE 5.—*Estimated cost of producing oats per acre and per bushel in the United States in 1909.*[1]

Item.	United States.	New York.	Ohio.	Illinois.	Michigan.	Wisconsin.	Minnesota.	Iowa.	Nebraska.	North Dakota.	Montana.
Commercial fertilizer..	$0.40	$1.99	$0.85	$0.12	$0.56	$0.08	$0.16	$0.05	$0.08	$0.03	$0.00
Preparation.....	$1.88	$3.75	$2.46	$1.32	$3.02	$2.40	$1.85	$1.23	$1.15	$1.91	$2.53
Seed.....	$1.12	$1.55	$1.06	$1.11	$1.05	$1.20	$1.11	$1.20	$0.98	$0.91	$0.95
Planting.....	$0.44	$0.66	$0.47	$0.30	$0.43	$0.54	$0.40	$0.37	$0.40	$0.44	$0.55
Harvesting.....	$1.34	$2.01	$1.41	$1.15	$1.50	$1.44	$1.42	$1.26	$1.22	$1.06	$1.70
Preparing for market..	$1.51	$1.85	$1.43	$1.41	$1.40	$1.51	$1.47	$1.48	$1.26	$1.80	$2.15
Miscellaneous.....	$0.44	$0.56	$0.38	$0.39	$0.46	$0.37	$0.52	$0.42	$0.47	$0.39	$0.55
Land rental or interest on land value.....	$3.78	$3.22	$4.04	$5.54	$3.41	$3.76	$2.66	$4.50	$3.68	$2.17	$3.30
Cost per acre....	$10.91	$15.59	$12.10	$11.34	$11.83	$11.27	$9.59	$10.51	$9.24	$8.71	$11.73
Yield per acre, 1909 (bushels).....	35.2	37.9	37.1	38.3	36.8	36.7	34.2	35.8	30.5	33.3	51.0
Cost per bushel, 1909...	$0.31	$0.41	$0.33	$0.30	$0.32	$0.31	$0.28	$0.29	$0.30	$0.26	$0.23
Average yield per acre, 1910–1914[2] (bushels)..	30.46	31.96	34.80	32.64	32.20	32.08	31.80	35.00	24.96	25.12	42.86
Average cost per bushel, 1910–1914[3]...	$0.35	$0.48	$0.34	$0.34	$0.34	$0.35	$0.30	$0.30	$0.37	$0.34	$0.26

[1] Crop Reporter, June, 1911, p. 47.
[2] Average of yields as given in the Yearbooks of the Department of Agriculture.
[3] Estimated in terms of average yields for the 5-year period, and cost per acre as reported by correspondents.

TABLE 6.—*Estimated cost of producing oats per acre and per bushel in Canada in 1911.*[1]

Item.	Canada.	Nova Scotia.	New Brunswick.	Quebec.	Ontario.	Manitoba.	Saskatchewan.	Alberta.	British Columbia.
Commercial fertilizer		$5.10							
Preparation	$3.03	$4.27	$3.00	$4.00	$3.28	$2.10	$3.00	$2.88	$5.45
Seed	$1.27	$2.20	$1.81	$1.79	$1.16	$0.93	$1.00	$1.00	$2.12
Seeding and cultivation	$0.91	$1.25	$1.14	$1.43	$1.00	$0.79	$0.88	$0.70	$1.36
Harvesting	$1.58	$2.31	$2.00	$1.86	$1.58	$1.28	$1.26	$1.65	$2.76
Threshing	$2.68	$2.23	$1.90	$1.66	$1.76	$2.85	$4.11	$3.27	$3.51
Wear and tear on implements	$0.45	$0.42	$0.49	$0.38	$0.54	$0.39	$0.46	$0.41	$0.37
Rental value	$2.69	$2.27	$3.15	$2.83	$2.85	$2.88	$2.36	$2.38	$6.80
Cost per acre	$12.61	$20.05	$13.49	$13.95	$12.71	$11.22	$13.07	$12.29	$22.37
Yield per acre, 1911 (bushels)	41.0	35.0	33.0	35.0	31.0	47.0	48.0	50.0	[2] 30.0
Cost per bushel	$0.30	$0.57	$0.40	$0.39	$0.41	$0.23	$0.27	$0.24	$0.74
Average yield per acre, 1910–1914 [3] (bushels)	34.96	30.89	29.61	27.56	33.68	35.83	38.17	41.09	54.13
Average cost per bushel, 1910–1914 [4]	$0.32	$0.64	$0.45	$0.50	$0.37	$0.31	$0.34	$0.29	$0.41

[1] Census and Statistics Monthly, March, 1912, pp. 54–56.
[2] As given in the Census and Statistics Monthly. Probably intended for 60, as the average yield per acre for all farms in British Columbia in 1911 was 52.50 bushels.
[3] The Canada Yearbook, 1915, pp. 146–168.
[4] Estimated in terms of average yields for the 5-year period and the cost per acre as reported by correspondents.

Without attempting to make any allowance for the difference between the Winchester and Imperial bushel,[5] or for the possible difference between costs per acre in 1909 and 1911, the cost of producing a bushel of oats appears to have been only 1 cent greater in the United States than in Canada, and the advantage in favor of Canada is increased to but 2 or 3 cents in a comparison of the leading oat-producing States and Provinces. When the cost per bushel is calculated for the five-year period 1911–1914, in terms of the average yield per acre and estimates of the American and Canadian correspondents as to costs per acre in 1909 and 1911, respectively, the relation between costs per bushel in the important oat-growing States and Provinces is somewhat changed. For the countries as a whole, the cost of production becomes 3 cents per bushel greater in the United States than in Canada, but costs in comparable States and Provinces show little or no advantage in favor of Canada. If allowance were made, however, for the difference in the legal measures of capacity, and the fact of rising costs per acre from 1909 to 1911, the results would probably show a larger difference between the costs of production in the two countries.

These costs include land rental or interest, which is considerably higher in the United States than in Canada. If this charge be omitted, costs in the States become, on the whole, somewhat less than in the Dominion. It should also be noted that costs per acre, both as to total and nearly all items of costs other than land rental or interest and commercial fertilizer, are higher in Canada than in the

United States, $1.70 per acre more, including land rental or interest, and $2.79 more without this charge. The cost of production on sod land is usually higher than on old land. More power is required for plowing, and more cultivation is necessary to prepare the seed bed after plowing. But in Canada higher costs per acre are offset by higher yields.

Offsetting factors.—There are other factors of comparative advantage which do not appear in figures of cost. In the important oat-producing States, and to some extent in eastern Canada, oats are grown in rotation with other crops, whereas in the western Provinces the practice, wasteful of soil fertility, of growing grain constantly is still prevalent. This exhaustion of soil fertility does not appear in the cost statements. The crop rotation generally practiced in the western Provinces takes the form of three or four years of grain followed by summer fallowing to rest and clear the land. Consequently there is a complete loss of revenue, ranging from every alternate year to one out of every four or five years. Such methods are doubtless more profitable in the present economic condition of the Provinces.

In the States, furthermore, it is the general practice to sow grass seed with oats and wheat, thus saving the expense of preparing and seeding for subsequent grass crops. And a further advantage is the larger use in feeding, and higher value, of oat straw in the more intensive agriculture of the United States—straw thus forming a more valuable by-product south of the border.

FARM AND URBAN CONSUMPTION.

Disposal of oat crop.—Something should be said of the character of the domestic trade and consumption of oats to make clearer the competitive possibilities of domestic and foreign crops. According to the census of 1909, only about a third of the American oat crop is sold; and later estimates of the Department of Agriculture, based upon reports of many thousands of the crop correspondents, show that farm consumption absorbs normally about 72 per cent of the total. Thus by far the larger proportion of the crop never leaves the farms on which it is grown. Of this farm consumption about 67.8 per cent is fed to horses, 13.2 per cent to cattle, 10.8 per cent to swine, 2.3 per cent to sheep. and 5.9 per cent to poultry.

The census figures for 1909 and 1914 indicate a consumption of oats in flour mills of only 50 million bushels, of which 36 million bushels were manufactured "chiefly for human food" and 14 million bushels "chiefly for live stock." This consumption for human food—oatmeal, rolled oats, and "breakfast foods"—constitutes about

3 per cent of a crop of 1¼ billion bushels. An additional 7.6 per cent of the crop is used for seed, while exports and imports are usually unimportant. This would indicate a consumption by live stock of between 85 and 90 per cent of the crop. Apparently about 15 per cent of the production is consumed by horses and other live stock in urban centers.

Character of American markets.—The fact that over 70 per cent of the crop is consumed on farms, and that a still larger proportion is fed to farm and urban live stock, is brought out to develop three points in particular. Some reference has already been made to the elasticity of the demand for oats and the relation between the prices and consumption of oats and other feedstuffs and the prices of live stock. Domestic markets adjust themselves from year to year without especial difficulty to variations in harvest and in domestic consumption, and these variations are not infrequently greater than the total amount of oats that enter international trade. In 1911 about 922 million bushels were produced and consumed within the United States; in the following year domestic consumption was increased by nearly 500 million bushels (production 1.4 billion bushels, exports less than 36.4 million, imports 0.7 million bushels), and in the year thereafter, 1913, fell by nearly 300 million bushels (production 1.1 billion, exports 2.7 million, imports 22.2 million bushels). Again, although the harvest of 1914 yielded a crop approximately equal to that of 1913, the higher prices caused by the European war resulted in an export of nearly 100 million bushels.

The second point is that, as a raw material used in feeding farm animals, the farmer can sometimes with profit grow and feed oats when at prevailing prices it is unprofitable to ship to markets. While an important source of income, oats do not rank, as do wheat or cotton, as a "cash crop," and the grower is perhaps in a more strategic position with regard to markets. For instance, the high prices of 1916 drew to the leading primary markets 50,000,000 bushels more than in 1915, although the crop was 300,000,000 bushels less. Of the important oat-producing regions, a considerably larger proportion of the crop is retained for farm consumption in the trans-Mississippi States, which are less favorably situated as to trade routes owing to distance and higher costs of transportation. Here producers receive lower prices for oats than in any other section. In the East and South, which are regions of deficient production, a very small proportion of the local crop is marketed. In the Pacific States, especially California, where oats and corn are scarce and high in price, barley is often substituted as a feedstuff.

Finally, with regard to the farm consumption and the marketable surplus, the potential competition affects more directly the third of

the crop that is sold, and especially that part of it which moves to urban centers. But this city demand fixes the general level of prices, and is an important reliance of the farmer for immediate funds. The proportion of this movement may be seen from the following table of receipts at the important primary markets. The greater portion of these receipts is reshipped, of course.

TABLE 7.—*Receipts and shipments of oats at primary markets.*

[From Bulletin 758, U. S. Department of Agriculture.]

[Figures are five-year averages, 1911 to 1915, unless otherwise noted.]

Market.	Receipts.	Shipments.	Excess receipts over shipments.
EAST OF THE ROCKY MOUNTAINS.			
Primary markets:	*Bushels.*	*Bushels.*	*Bushels.*
Chicago	000	104,622,000	17,152,000
St. Louis	000	15,409,000	6,708,000
Minneapolis	000	20,213,000	1,295,000
Milwaukee	000	18,125,000	1,495,000
Omaha	000	[1] 13,509,000	
Peoria	000	[1] 11,717,000	
Kansas City	000	6,203,000	1,516,000
Cleveland	000	1,606,000	5,813,000
Cincinnati	000	5,076,000	2,112,000
Duluth	000	[1] 6,626,000	
Indianapolis	000	2,405,000	3,837,000
Louisville	000	4,240,000	1,797,000
Toledo	000	3,770,000	791,000
Detroit	000	743,000	3,080,000
Total [2]	258,262,000	214,359,000	45,596,000
Other markets:			
Buffalo	12,685,000	(3)	(3)
		Exports.	
New York	27,071,000	8,001,000	19,070,000
Baltimore	15,726,000	12,310,000	3,416,000
Philadelphia	11,143,000	3,567,000	7,576,000
Boston	4,539,000	789,000	3,750,000
New Orleans	6,089,000	700,000	2,389,000
PACIFIC MARKETS.			
Seattle	2,344,000	764,000	1,580,000
San Francisco	2,049,000	259,000	1,790,000
Portland, Oreg. [4]	2,286,000	1,327,000	959,000

[1] In these cases shipments apparently exceed receipts, according to the original reports.
[2] Allowance should be made for some duplication in receipts due to the practice of intermediate markets in crediting themselves with through shipments.
[3] No data.
[4] Data for 1915 only.

TRADE OF THE UNITED STATES AND CANADA.

Compared with the volume of production, the foreign trade of both the United States and Canada during the period 1902–1914 has usually not been important. But within the later years it was marked by certain significant tendencies, viz:

Great as has been the increase in production within the United States, it has evidently not kept pace with the needs of the domestic markets. Oat exports reached their highest figure toward the close of the last century, when they ranged from 30 to 70 million

bushels (1897–1901). From that time on they dwindled rapidly; during 1908–1914 (except the fiscal year 1913) exports amounted to but 1 or 2 million bushels annually. Moreover, from one-fourth to one-half of these exports were from the Pacific States. In the decade preceding the World War imports frequently exceeded exports, and, while variable in volume, they were increasing. (See Table 8.) Exports of oatmeal also declined from an average of 350,000 barrels during 1897–1901 to 125,000 barrels in 1910–1914.[1]

TABLE 8.—*Oat and oatmeal trade of the United States, 1897–1920.*

[From United States Commerce and Navigation Reports. Fiscal years ending June 30.]

Year.	Imports of oats.		Exports.	
	Total.	From Canada.	Oats.	Oatmeal.
	Bushels.	*Bushels.*	*Bushels.*	*Barrels.*[1]
1897	46,459	[illegible]06	[illegible]26	241,379
1898	9,098	38	28	436,226
1899	11,500	80	78	296,135
1900	41,523	43	15	237,908
1901	20,735	84	12	470,390
1902	25,512	33	30	303,556
1903	127,416	40	09	346,040
1904	170,883	73	14	74,115
1905	38,773	76	08	267,739
1906	22,675	39	85	193,789
1907	74,552	07	42	217,864
1908	364,307	26	22	124,010
1909	6,666,999	36	20	75,627
1910	1,034,511	[illegible]	74	79,280
1911	107,318	[illegible]	12	165,302
1912	2,622,357	[illegible]	03	46,492
1913	723,399	[illegible]	77	247,619
1914	22,273,62[illegible]	[illegible]1	49	31,624
1915	630,[illegible]22	[illegible]	51	343,954
1916	666,314	[illegible]4	84	279,330
1917	761,644	[illegible]6	01	505,533
1918	2,591,077	98	09	1,708,180
1919	551,355	55	74	1,161,162
1920	6,043,394	61	40	871,715

[1] Barrels of 196 pounds (the product of 10.88 bushels of oats).

In Canada, however, exports have been steadily attaining higher levels since the year 1905, while imports have always been insignificant. Although the Canadian crop was only about one-third that of the States from 1908 to 1914, inclusive, exports were several times as large. Canadian exports of oatmeal also increased and usually exceeded those of this country.

[1] One barrel of oatmeal (196 pounds) equals 10.88 bushels of oats.

TABLE 9.—*Oat and oatmeal trade of Canada, 1902–1920.*

(From Canadian Trade and Commerce Reports.)

Year.[1]	Imports entered for home consumption.		Exports of oats.		Exports of oatmeal (home produce).
	Total.	From the United States.	Total.	Shipped in bond through American ports.	
	Bushels.			*Bushels.*	*Barrels.*[2]
1902	138,113	65	28		91,700
1903	100,811	11	77		144,536
1904	61,513	96	61	2 107	204,404
1905	508,786	67	69	1 21	168,607
1906[3]	46,268	00	03	04	132,944
1907[4]	6,589	67	36	1 34	136,839
1908	112,935	31	01	02	164,864
1909	454,093	28	10	27	119,448
1910	38,945	01	30	75	247,297
1911	10,380	00	02	1 03	126,240
1912	33,245	02	75	1 08	209,679
1913	207,281	42	54	1 03	188,987
1914	61,974	06	04	6 08	111,537
1915	1,411,400	33	06	4 06	60,328
1916	2,762,388	03	32	15 22	92,913
1917	1,376,023	23	32	22 54	90,902
1918	22,277	77	02	16 22	281,333
1919	4,276,914	14	12	1 04	388,531
1920	3,139,260	01	72	3 84	41,083

[1] Fiscal years ending June 30 from 1902–1906; after 1906, fiscal years ending March 31.
[2] Equivalent to 196 pounds.
[4] Nine months.

A very considerable proportion of the Canadian exports were shipped in bond via important consuming markets of the States, and some surplus producing sections of the Dominion are favorably situated with respect to deficiency sections across the border. Despite these conditions, it was only about three times in the 15 years, 1902–1916, that exports to the United States exceeded a million bushels. The import duty of 15 cents per bushel was virtually prohibitive, except as regards a small and variable border trade arising out of local crop conditions, a shortage of good seed oats or of the higher grades in demand for oat milling. The record import of 22 million bushels occurred in the fiscal year 1914, following the reduction of the duty to 6 cents. But in that year there was a short domestic crop not only of oats but of other feedstuffs, especially corn, barley, and hay. Since the reduction in the American customs duty, and during the war period, the volume of shipments across the border, though still unimportant, has increased somewhat.[5] However, the present duty of 6 cents is higher than the prewar ocean freight to the principal trans-Atlantic markets.

Canada has had no such advantage over her competitors in the world markets for oats as in the case of her hard spring wheat. This, together with the American customs barriers, has prevented a

[5] In addition to oat imports (usually less than 1,000,000 bushels), oatmeal and hulls to the value of about $250,000 are annually imported from Canada.

greater development of her export trade. Free trade between the two countries would tend to direct her product southward either for concentration and reshipment from the primary markets or for American consumption.

LIMITATIONS UPON EXPORTS OF OATMEAL.

The decline in the exports of American oatmeal, prior to the World War, has been synchronous with the decline in oat exports. Here, as in the case of wheat, the duty on the miller's raw material has possibly tended to diminish the importance of his foreign market, when that market might have been extended had he had free access to Canadian oats. For milling purposes the northern product is superior. Its superiority grows out of the climatic conditions under while it is grown. If it is cool when oats are filling, the grain will be plump and heavy, admirably suited to the manufacture of oatmeal. If the weather is hot during that period the grain will be shrunken; if too humid or wet, the oats will be rusty, and the yield small. Owing to the more favorable climate and the abundance of fresh fertile land, the Canadian yield of oats per acre is larger than the yield in the United States, and on the whole the grain is much heavier to the measured bushel.

But, while the duties on oats and the difficulties of the drawback system probably had some retarding influence upon American exports of oatmeal or rolled oats, the domestic miller labors under other disadvantages, which are perhaps more burdensome. Costs of transportation, by rail or water, for equal units of weight, are materially higher on oatmeal than on the grain;[9] and as the volume of trade in oat products is much smaller, and rates for less than a carload are higher than those for a carload, this difference would be further accentuated. Such disadvantages are even more marked in the ocean freights. A further obstacle is the tendency of foreign tariffs to discriminate against manufactured products. Local tastes as to oat products differ also; and in the production of oatmeal there is the advantage of the local value of the by-products for feeding purposes. It is therefore evident that in view of such conditions, and of the fact that large quantities of oats are produced in the importing countries, there is no especial economic advantage operating in favor of the American manufacturer to offset these disadvantages.

REGIONS OF SURPLUS AND DEFICIENT PRODUCTION.

Canadian or other foreign competition with American oat growers affects producers throughout the United States very unequally. The

[9] For export, carload rates, all rail Chicago to New York, September 15, 1920: Grain, 13 cents per 100 pounds; grain products, 35 cents per 100 pounds.

oat crop of the Pacific States usually enters into a trade apart from that of the rest of the country; rail rates eastward are prohibitive, and the surplus of Washington and Oregon ordinarily moves southward to California, or is exported through the Pacific ports. Canadian competition in the Pacific States is as yet unimportant; the crop of British Columbia is small. Only a small fraction of the land in this Province is suitable for cultivation.

Annual estimates of "shipments out of counties where grown," by States, furnish an indication of the volume of the domestic trade in oats, and to a certain extent show also the regions of surplus and deficient production. During the years 1911–1915 such shipments approximated 361 million bushels, or 29 per cent of the domestic crop, and 84 per cent of the total, or 302 millions, originated within the North Central States, which contain 17 per cent of the land area. (See Table 2.) This 84 per cent constituted only about a third of the crop of this great live-stock producing region, local consumption absorbing the balance, nearly one-half the national crop. Of the 90 million bushels of oats produced annually in the North Atlantic States, during the years 1911–1915, only 5 million bushels were reported to have been moved out of countries where grown. In the South, during the same period, 18 million bushels were shipped out of the producing counties out of a crop of 114 millions, and in the Mountain States 20 out of 65 millions.

These figures of shipments out of counties are published by State units; they show the gross surplus of counties, and do not necessarily indicate movement out of the State, as they do not allow for the movement between regions of surplus and deficient production within the same State. If from the total of such shipments the figures for the Pacific States be deducted—about 10 per cent of the total—and if allowance be made for the local movement between counties, it will be seen that the North Central States ship nearly all of the oats east of the Rockies that enter into general channels of trade. With some unimportant exceptions, all other regions produce less than their requirements.[10]

The largest markets for this surplus are in the East—for urban and farm consumption—and in the South; there is also some movement to the West. The flow of oats to these regions of deficient production far outweighs the exports of the United States and Canada, and in fact the domestic trade in this product exceeds in volume the entire international trade. Thus the difference between receipts and shipments in New York City, which composes the apparent consumption there, during 1911–1915 averaged 19 million bushels; and this

[10] The foregoing data with regard to trade routes are taken from U. S. Department of Agriculture Bul. 755, Geographical Phases of Farm Prices: Oats, by L. B. Zapoleon.

amount was larger than the combined average annual exports of Canada and the United States prior to 1914, and was several times larger than the quantity of oats marketed by eastern farmers. What the opening of this market may mean to the Canadian producer is indicated in some measure by the price data which follow.

COMPARATIVE PRICES.

Markets and standards of grading.—In the diagrams facing pages 93 and 94 there has been charted the course of wholesale prices, for several years before and after the reduction in the American import duty, in two American and two Canadian markets located on or near the international boundary line, and in Liverpool. The North American markets are well suited for the purpose of making a comparative study of oat prices, Buffalo and Toronto in the East, and Chicago and Winnipeg in the West. Moreover, the volume of their receipts and shipments of oats is sufficiently large to make their price quotations representative of the conditions obtaining in the eastern and western sections of both countries. Virtually all of the surplus of the western Provinces is concentrated at Winnipeg, while Chicago receives about four times as much oats as any other American market.

In comparing oat prices, however, there are the same difficulties to be contended with that were encountered when comparing wheat prices. The chief difficulty lies in the different methods of grading and inspection in vogue in different markets. For instance, No. 2 oats, for which Winnipeg price quotations are given, are required (by the Canada Grain Act, effective Apr. 1, 1912) to be "sound, reasonably clean, reasonably free from other grain, and shall weigh not less than 34 pounds to the bushel." In the eastern division of Canada—that is, in the Toronto market—No. 2 white oats "shall be sound, reasonably clean, and reasonably free from other grain, and shall weigh not less than 32 pounds to the bushel." The commercial grades formerly in effect at Chicago and Buffalo differed slightly from the uniform Federal grades now in force in all American markets. In the United States, official standards for oats went into effect on June 16, 1919.[11] Prior to that time the Buffalo grade followed that of Chicago, where No. 2 white oats, as fixed by the State Public Utilities Commission of Illinois, "shall be 95 per cent white,

[11] The official oat standards of the United States, effective June 16, 1919, are definite and specific in their requirements: No. 2 oats "shall be cool and sweet, and may be slightly stained; minimum test weight per bushel, 29 pounds; not less than 95 per cent sound cultivated oats; not over three-tenths of 1 per cent heat-damaged oats and other grains; not over 2 per cent foreign materials; not over 3 per cent wild oats; not over 5 per cent other colors in white oats or 10 per cent of other colors in red, gray, or black oats."

dry, sweet, shall contain not more than 1 per cent dirt and 1 pe cent of other grain, and weigh not less than 29 pounds to the meas ured bushel."[12] In both countries sales of oats are by weight, th legal weight of a Canadian Imperial bushel being 34 pounds and o the American Winchester bushel 32 pounds.

Thus the standards upon which oat grades are based are higher i Winnipeg than in Toronto, and higher in both markets than i Chicago and Buffalo. The Buffalo and Toronto quotations afford better basis for comparing American and Canadian prices than th quotations in the western markets, as the complications introduce by the open and closed navigation season in the Lakes are thu lessened. But in making comparisons on the same grades betwee the eastern markets it must be remembered that the Toronto quota tions are for a larger quantity of oats and a better quality—sinc the test weight per bushel is one of the chief indications of quality— than the Buffalo prices. If the prices in the latter market were t be exactly comparable, the standard of grading should call for quality of oats that would weigh 31.02 pounds to the measure (Winchester) bushel instead of 29 pounds.

Buffalo and Toronto prices.—This difference in quantity an quality should apparently be reflected in higher prices for th Canadian product, in comparable markets. But the reverse wa true. In the period from 1906 to 1916, inclusive, Buffalo price exceeded Toronto prices 109 times, for a total of 719¾ points, whil Toronto prices exceeded Buffalo prices 22 times, for a total of 58½ points. From another point of view the comparison may be drawn as follows:

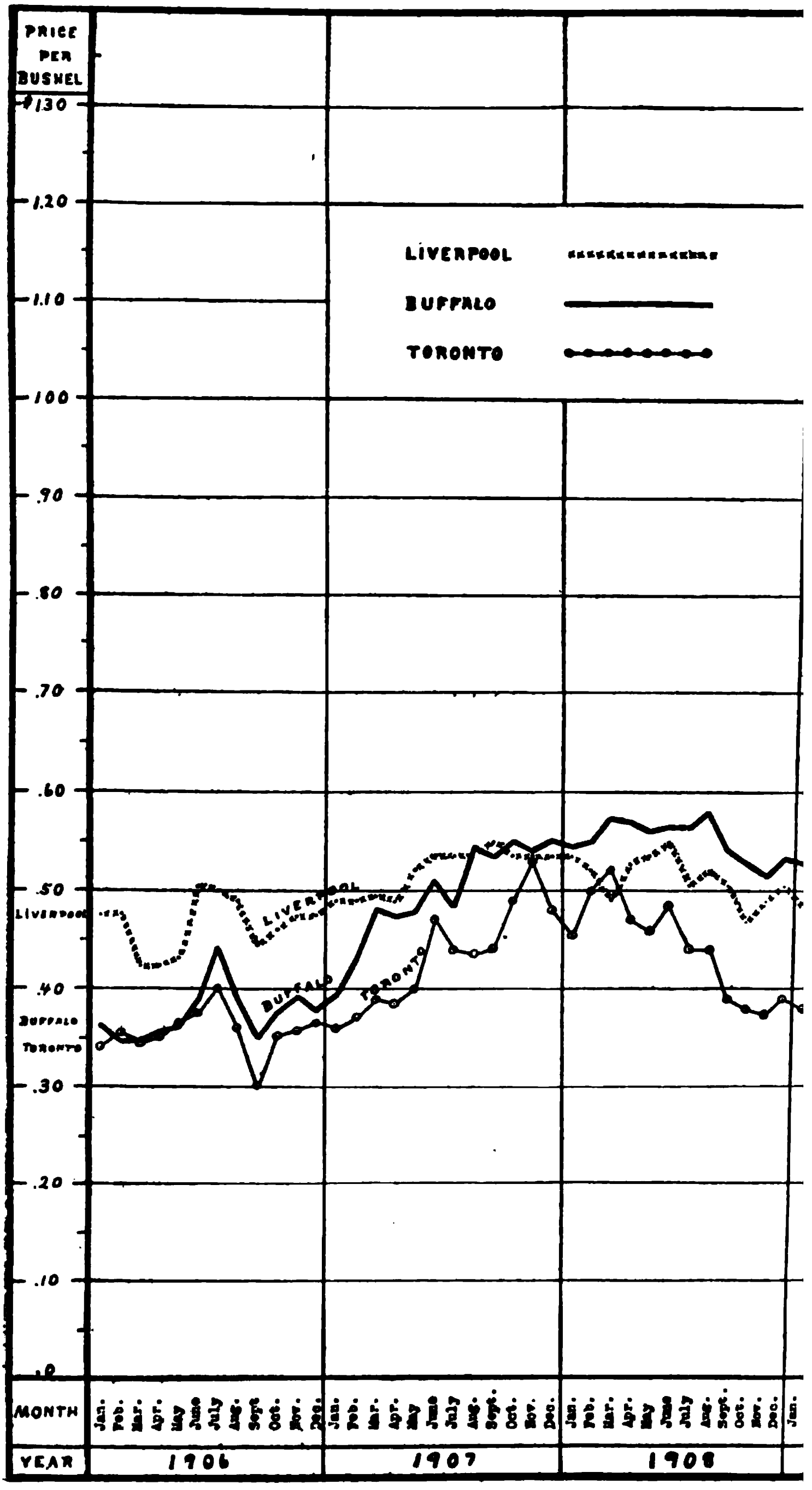
	Number of times
Buffalo prices were higher	10
By 5 cents or less	53
By more than 5 and less than 10 cents	33
By 10 cents or more	23
Toronto prices were higher	2
By 5 cents or less	18
By more than 5 and less than 10 cents	4
Buffalo prices and Toronto prices were the same	1

It will be observed from the price statistics in Table 9 that the spread between the American and Canadian prices was much greater while the import duty of 15 cents a bushel was in force. In the period from 1907 to 1913 the Buffalo price was almost constantly above the price in Toronto, and in many cases the difference was almost equal to the amount of the duty (15 cents per bushel). This

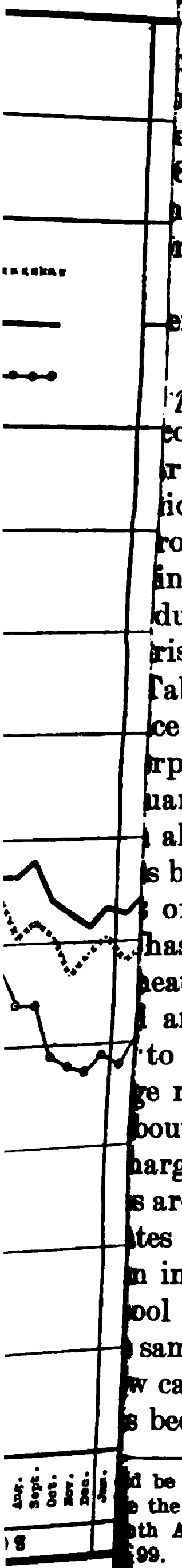
[12] Fifty-eighth Annual Report of the Trade and Commerce of Chicago, Chicago Board of Trade, p. 85.

UNIV. OF MICH.

CHART 1.—PRICES OF OATS AT LIVERPOOL, TORONTO, AND



1823—20. (To face p. 93.)



y true in the fiscal years (ending June 30) 1909, 1910, years when our imports of oats amounted to more than hels. After the reduction of the duty in October, 1913, ushel, the greatest excess of the Buffalo price over the e at any one time, that is, on the first market day of a 8¾ cents, and this excess was reached only in winter the importation of grain was attended by greater n cost. The most continuous excess from month to October, 1913, occurred in the fiscal year ending June en over 22,000,000 bushels of oats were imported from

prices on an export basis.—Chart 2 (facing p. 94) ourse of prices at Chicago, Winnipeg, and Liverpool r conditions; prices in Winnipeg were usually well below icago, the difference being most pronounced when the rop was short and least noticeable when both countries ing largely; and a narrower spread after the reduction in duty.

rison of the Winnipeg prices with the Liverpool quota- Table 10) shows that until the outbreak of the European ce of oats in Winnipeg invariably ranged below the price rpool market by an amount varying from 8 to 29½ cents uary months and from 2 to 17½ cents in the July quota- all except one year, 1907, the difference between the two s been greater in January than in July.

of transporting oats from North American markets to has fluctuated no less, relatively, than the cost of trans- eat. But as the movement of oats to European ports has and irregular compared with the movement of wheat, to ocean freights are frequently unavailable. However, e rate on a bushel of oats from Chicago to Liverpool is out two-thirds the average rate on a bushel of wheat; the harges bear approximately that relation to one another s are officially quoted on both grains.[14] The average annual tes on wheat from Chicago to Liverpool by various routes n in Table 19, p. 59. The water rates from Fort William ool during the Canadian navigation season have been vir- same as the water rates from Chicago.

w cases the difference between the Winnipeg and Liverpool s been less, from month to month, than the lowest average

d be noted that the Liverpool quotations are for the first Tuesday of each e the quotations in Winnipeg are for the first market day of each month.
th Annual Report of the Trade and Commerce of Chicago, Chicago Board 99.

anual freight rate from Chicago. This was notably true of the fis years 1908 and 1909, when Buffalo prices exceeded those at Liv pool. In the latter year there was a marked diminution in Canad oat exports to Great Britain, because it was more profitable to exp to the United States, transportation charges were lower, and price to be obtained in the American market was even higher than price in Liverpool. The volume of Canadian oats imported into United States in 1909 represented nearly the total of Canad oat exports.

American prices usually above the export basis.—A comparison American and Liverpool prices shows that they have been fairly dependent of one another. In 1907, a short crop year, the Buff price rose well above the export point and finally exceeded the pr in Liverpool. Throughout the following year (also a year of sc production) and during the first six months of 1909 the Buffalo pr remained above the Liverpool price, and so exceeded the price Canada as to cause the large importation in the fiscal year 1909 the face of an import duty of 15 cents a bushel. Even the Chic quotations exceeded the Liverpool price in the fiscal years 1908 a 1909.

Again, throughout the year 1910, the greater part of 1911, and t first eight months of 1912, the Buffalo price hovered around t Liverpool price, causing the importation of the fiscal year 1912. T American oat crop of 1911 was well below that of normal years, t yield per acre being only 24.4 bushels, while the crop in Cana averaging 37.92 bushels per acre, was one of the largest on record that country. The following two years were also record years Canada and, although there were fairly bountiful crops in t United States, Buffalo prices during the last six months of 1913 a the first half of 1914 were not far below the Liverpool quotatio and they exceeded Toronto prices by an amount sufficient to perr the importation of over 22,000,000 bushels of oats dutiable a cents a bushel in the fiscal year 1914. In only two fiscal years in t period 1904 to 1914, inclusive, namely, 1906 and 1913, have the Bu falo prices been low enough to permit the movement of oats in a considerable quantity to European markets.

NTS TO 6 CENTS, TARIFF ACT OF OCTOBER 3, 1913.

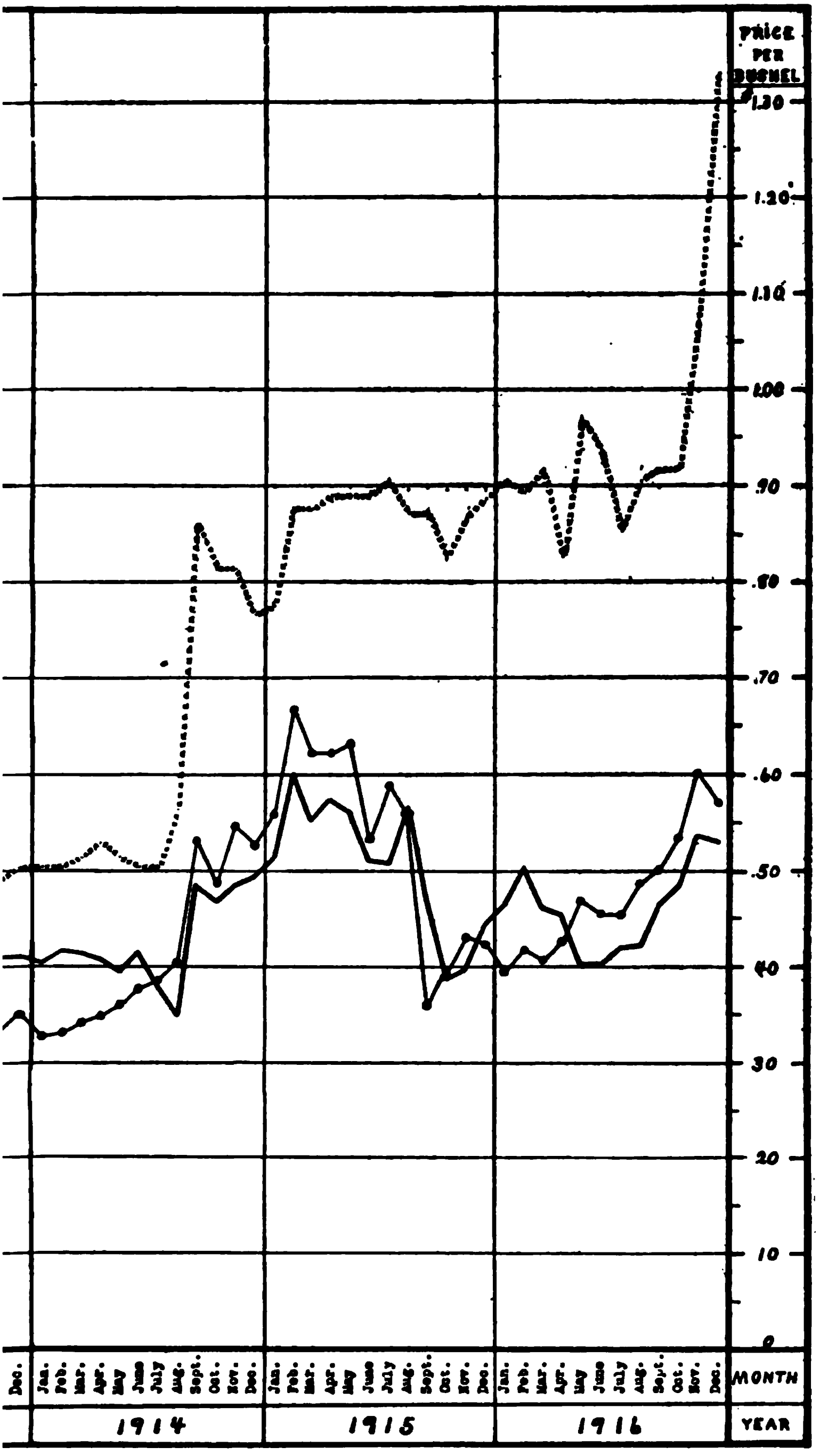


TABLE 10.—*Prices of oats at Liverpool, Chicago, Buffalo, Winnipeg, and Toronto, on or about the first Monday of each month, 1906–1916.*[1]

[Wholesale prices, No. 2 "cash" oats.]

Market.	Jan.	Feb.	Mar.	Apr.	May.	June.	July.	Aug.	Sept.	Oct.	Nov.	Dec.
1906.												
Liverpool	a 47½	a 47½	a 42½	a 42½	a 43	50½	50	49	44½	46	47½	47½
Toronto	34	35½	34½	35	36½	37½	40	36	30	35½	35⅞	36½
Buffalo	36½	34½	34½	35½	36½	39	44½	39	35	37½	38½	37½
Excess Buffalo over Toronto	1½	−1	0	½	−½	1½	4½	3	5	2½	2½	1½
Winnipeg	32	32½	33½	33	36	37	35½	34½	32½	34	34½	34½
Chicago	32½	31½	31⅞	32	34	34⅞	40⅞	32	32⅞	34⅞	34⅞	35½
Excess Chicago over Winnipeg	½	−1	−1½	−1	−2	−2½	5½	−2½	½	⅜	½	1½
1907.												
Liverpool	49	49	49½	49	52	53½	53½	53½	55	a 53½	a 53½	a 53½
Toronto	36	37	39	38½	40	47	44	43½	44	49	53	48
Buffalo	39½	43	48	47½	47½	51	48½	54½	53½	55	54	55
Excess Buffalo over Toronto	3½	6	9	9½	7½	4	4½	11	9½	6	1	7
Winnipeg	35	36½	35½	35⅜	37⅝	40	39	38½	40	50⅛	47	45½
Chicago	36	38½	43	43	45	48	44	49	52½	54	52	50
Excess Chicago over Winnipeg	1	3	7½	7½	7⅜	9	5	10½	12½	3⅞	5	4½
1908.												
Liverpool	a 53½	a 52	a 49	a 52⅜	a 53½	a 55	a 50½	a 52	a 50½	a 46⅜	a 49	a 50½
Toronto	45½	50	52	47	46	48½	44	44	39	38	37½	39
Buffalo	54½	55	57½	57	56	56½	56½	58	54	52⅜	51½	53½
Excess Buffalo over Toronto	9	5	5½	10	10	8	12½	14	15	14⅜	14	14½
Winnipeg	38	38	40	40	41	42	42	41	40	38½	37⅞	36⅜
Chicago	57	54	53½	53½	55⅜	54⅜	53	51	50½	51	50	50½
Excess Chicago over Winnipeg	19	16	13½	13½	14⅜	12⅜	11	10	10½	12½	12⅛	13½
1909.												
Liverpool	a 48½	a 49½	a 53½	a 52⅜	a 56½	a 58	a 59½	a 62	a 56½	a 56½	a 56½	a 53½
Toronto	38	41	46	45	45½	59	57	53	44½	35	37	37
Buffalo	52⅜	54½	56½	57½	59½	63½	56	51	39½	43½	44½	44
Excess Buffalo over Toronto	14⅜	13½	10½	12½	14	4½	−1	−2	−5	8½	7½	7
Winnipeg	37½	39	42½	41⅜	44½	53½	54	37	33	34½	34	32½
Chicago	51	53	55	55½	57½	60	52	41	39	41	41½	42½
Excess Chicago over Winnipeg	13½	14	12½	13⅜	13½	6⅜	−2	4	6	6½	6½	10

[1] Sources:

Liverpool.—Prices for 1913–1916 are from the Canadian "Census and Statistics Monthly" and Canada Yearbook. Prices for 1906–1912 were compiled from Broomhall's Corn Trade News. Quotations on or about the first Monday of each month for Canadian oats whenever available. When prices for this grade were unobtainable a comparable substitute grade was taken, usually Chilean oats. Such substitutions are marked "*a*".

Chicago.—No. 2 white oats on or about the first Monday of each month. Compiled from "Daily Trade Bulletin," Chicago.

Buffalo.—No. 2 white oats, on or about the first Monday of each month. Compiled from the Northwestern Miller.

Winnipeg.—No. 2 Canadian western in store at Fort William or Port Arthur, on or about the first Monday of each month. From "Wholesale Prices," Canadian Department of Labor.

Toronto.—No. 2 white Ontario, on or about the first Monday of each month. From "Wholesale Prices," Canadian Department of Labor.

TABLE 10—*Prices of oats at Liverpool, Chicago, Buffalo, Winnipeg, and Toronto on or about the first Monday of each month, 1906–1916*—Continued.

Market.	Jan.	Feb.	Mar.	Apr.	May	June.	July.	Aug.	Sept.	Oct.	Nov.	Dec.
1910.												
Liverpool	a 53½	a 53½	a 53½	a 58½	a 49	42½	42	46	47½	a 46	a 45	a 4
Toronto	35½	38	39	37	35	33	33	40	37	33	32½	3
Buffalo	49	51½	52½	48½	45½	41½	44	45	37½	36½	36	3
Excess Buffalo over Toronto	13½	13½	13½	11½	10½	8½	11	5	½	3½	3½	4
Winnipeg	34½	37	36	41	32	33½	34	39⅝	35⅝	33	32	3
Chicago	46½	48	48	46⅜	43½	39½	40⅜	38	34	34⅜	33⅜	3
Excess Chicago over Winnipeg	11⅞	11	12	5⅜	11½	6	6⅜	−1⅝	−1⅛	1⅜	1⅜	
1911.												
Liverpool	a 46	a 45	a 44½	a 46	a 48½	48½	46½	48½	49½	55	56	5
Toronto	32	33	32	31½	35	37	40	39	42	43½	47	4
Buffalo	36	36⅜	34½	33⅜	36½	41½	48	41⅜	47½	51½	50½	5
Excess Buffalo over Toronto	4	3⅜	2½	2½	1½	4½	8	2⅜	5½	7⅞	3½	
Winnipeg	32⅜	31⅜	29	32½	34½	35	36½	36½	39	42	40	3
Chicago	33½	32⅜	31½	32	33½	37	46½	39	44½	48½	47½	5
Excess Chicago over Winnipeg	⅛	1	2⅛	−½	−1	2	10	2⅛	5½	6½	7½	1
1912.												
Liverpool	55	58	56½	56½	56	a 61½	56½	a 53½	59½	62	62⅛	6
Toronto	46½	46½	48½	49½	51	51	51	45	43	42	42	4
Buffalo	53	56½	57⅜	61	61	57	52	60	36	37⅜	36½	3
Excess Buffalo over Toronto	6½	9⅛	9½	11½	10	6	1	15	−7	−4½	−5½	−1
Winnipeg	36½	40½	40⅜	46	49	44⅜	43	36½	43	46	35	3
Chicago	49½	52½	54½	56½	58½	53½	50½	45⅜	33½	33½	34	3
Excess Chicago over Winnipeg	12⅞	12	13⅛	10½	9½	8⅛	7½	9½	−9⅞	−12½	−1	−3
1913.												
Liverpool	56½	56½	56½	53	53	54½	54½	53	53	50	49	5
Toronto	37	37	37	36	36	36	37	37	37	36	36	3
Buffalo	37½	38⅜	37⅛	38½	41	43½	45½	46	44½	44⅜	44½	4
Excess Buffalo over Toronto	½	1⅜	⅛	2½	5	7½	8½	9	7½	8⅜	8½	8
Winnipeg	31	32½	32⅝	32⅞	34½	34½	34½	35½	34	35⅛	33½	3
Chicago	34⅛	36½	34⅝	36½	37½	41	42	42⅛	43	43	41	4
Excess Chicago over Winnipeg	3⅛	4½	1⅞	3⅝	3	6½	7½	7½	9	7⅞	7½	6
1914.												
Liverpool	50½	50½	51½	53	51½	50½	50½	56½	86½	81½	81½	7
Toronto	38½	38½	38½	42	42	43	43	43	52	45	48	4
Buffalo	43½	43½	44½	43⅜	43½	45	42½	42½	51⅜	49½	52½	5
Excess Buffalo over Toronto	5	5	5½	1⅜	1½	2	−⅜	−½	−½	4½	4½	3
Winnipeg	32⅞	33½	34½	35	36½	37⅜	38⅜	40½	53½	48⅜	54⅜	5
Chicago	40½	41⅜	41½	40⅜	39½	41½	38½	35	49⅜	46⅜	48½	4
Excess Chicago over Winnipeg	7⅝	8½	7½	5⅜	3½	3⅞	−½	−5½	−3⅜	−1⅞	−6½	−3

TABLE 10—*Prices of oats at Liverpool, Chicago, Buffalo, Winnipeg, and Toronto, on or about the first Monday of each month, 1906–1916*—Continued.

Market.	Jan.	Feb.	Mar.	Apr.	May.	June.	July.	Aug.	Sept.	Oct.	Nov.	Dec.
1915.												
Liverpool	77½	87⅞	87⅞	89½	89½	89½	90½	87½	a 87½	82⅞	86⅞	88⅞
Toronto	46	60	60	60	62	56	56	57	38	37	38	37
Buffalo	54⅜	62	59½	60⅜	59⅜	56½	55⅜	62½	37½	41	42	45½
Excess Buffalo over Toronto	8⅜	2	−½	⅜	−2½	½	−½	5½	−½	4	4	8½
Winnipeg	56	66⅜	62½	62½	63½	53½	59	56	36	39	43	42½
Chicago	51⅜	60½	55½	57½	56½	51	50⅞	56⅜	47	38⅜	39⅜	44½
Excess Chicago over Winnipeg	−4⅛	−6½	−7	−4⅛	−7	−2½	−8⅛	⅜	11	−½	−3½	2½
1916.												
Liverpool	90½	89½	91⅜	82⅜	97	93⅜	85½	90½	91⅜	91⅜	1.07½	1.33
Toronto	39	43	41	43	45	48	48	50	52	54	62	61
Buffalo	50½	53½	48½	49½	50½	42½	43⅜	48⅜	49½	51	56½	56½
Excess Buffalo over Toronto	11½	10½	7½	6½	5½	−5½	−4½	−1½	−2⅜	−3	−5⅜	−4⅜
Winnipeg	39½	41⅛	40⅛	42⅛	46⅜	45½	45½	48⅜	50⅛	53½	60½	57
Chicago	46½	50½	46	45½	40½	40½	42	42½	46½	48⅜	53⅛	53
Excess Chicago over Winnipeg	7	8⅜	5⅞	2⅞	−6½	−5½	−3½	−6½	−3⅛	−5	−6⅛	−4

AMERICAN AND CANADIAN MARKETS AND COMPETITION.

Geographical factors.—The great Canadian grain-growing Provinces extend westward from the border of North Dakota to the Rocky Mountains. Separating this region from the eastern Provinces is a strip of unproductive land several hundred miles wide, extending from Winnipeg to Georgian Bay. It is obvious that in competition with the important oat-growing States—Iowa, Illinois, Minnesota, Michigan—for the American markets in the South and East, these western Provinces are at a permanent geographic disadvantage which would be reflected in higher transportation costs and lower prices to producers. The eastern Provinces are, of course, more favorably situated with regard to the markets across the border than are the American regions of surplus production. But the American tariff of 15 cents a bushel from 1890 to 1913—the period during which Canadian grain became a factor in the world markets—was virtually prohibitive, since it was greater than the usual cost of transporting oats from lake ports to England, and the more competitive rate of 6 cents per bushel of the tariff act of 1913 is greater than the prewar ocean freight from Montreal to Liverpool.

Markets and trade routes.—Thus the American producer has an important advantage in the diverse character and much greater consumption of the protected domestic markets. While nearly the entire commercial supply of the western Provinces is handled through

Winnipeg, and moves eastward, several trade routes are open to the oat grower of the States, and there is keen competition between numerous primary markets, between ports, transportation, and other interests. For the northern product, Minneapolis, Chicago, and Buffalo are the natural gateways to the world markets. The tariff not only barred the Canadian from shipping to the South, but prevented the use of the concentrating and elevating facilities of the primary markets of the States. The lack of satisfactory year-round port facilities compels a movement in bond to the ports across the border.

The American producer has a further advantage in the greater elasticity of the home demand and consumption. The annual fluctuation in the amounts absorbed by the great live-stock industries and by the large numbers of live stock concentrated in the cities, is sometimes greater than the entire Canadian crop. Lacking such a market, and at a stage of economic development where such crops as oats are most profitable, the Canadian surplus moved to the world markets in competition with the product of such countries as Russia and Argentina. To take advantage of the lower water freights, and to avoid interest and storage charges, the great bulk of the surplus of the western Provinces is sent to and shipped from the primary markets shortly after harvest, and before lake navigation closes; this is the time of year when the European product is marketed and prices are usually lowest. An indication of the stronger position of the producer in the United States is that in Chicago, the greatest American primary market for oats, which receives between 100 and 150 million bushels annually, only about 5 per cent of the shipments are made via the Lakes notwithstanding the cheaper water freights.

Freight rates a protection to the eastern farmer.—Finally, it should be noted that farmers in the East and South—where oat production has increased as wheat raising has declined—are in a more favorable situation with regard to competition, either from the surplus-producing section or from Canada. Lowest prices are paid to producers of oats in the northwestern part of the oat-growing region, Minnesota and North Dakota; farm prices graduate upward steadily from this section to the East and West, and especially to the South. Highest prices are paid to producers in the Southeast and Southwest, where the price levels are higher than in the world markets. Obviously, in such deficiency regions the price of the local product—which may not have moved a mile—is determined by the price of the additional quantity shipped in to meet the local demands. This margin between prices in the eastern and western States, or the protection afforded the farmer in regions of insufficient production by costs of transportation, has narrowed rapidly since 1871, coinciding with the decline in rail rates, so that while producers' prices in

the surplus-producing States have increased, in the regions of deficient production they have declined (prior to the World War). Thus the average producers' price of oats during 1911–1915 in Iowa—a State of surplus production—was 35 cents; in New York—a State of insufficient production—47 cents, or a difference of 12 cents; but the difference in favor of New York producers was 23 cents during 1871–1875. (Iowa, 23 cents; New York, 46 cents.) The recent increases in rail rates have, however, again increased the protection of the eastern farmer. It was as a result of this increase that the margin between the fixed wheat prices in Chicago and New York was increased by the presidential proclamation of September 2, 1918, from 8 cents to 13½ cents.

A distinction should also be noted between the nature of the farm and of the urban demand in considering the possibility of competition. Reference has already been made to the fact that about 72 per cent of the whole crop is consumed on farms and that in the East and South an almost negligible part of the crop is sold. In competing for this farm demand, especially so far as eastern and southern producers are concerned, the difference between farm and market values has to be taken into consideration. In this connection, rural roads and distances to shipping points, as well as transportation facilities, are important factors. Prices in isolated regions are out of line with those of the rest of the country, whether there be a surplus or a deficiency. The cost of hauling from farm to market in many regions is often greater than shipping costs to European markets; this cost has been diminishing, however, with the spread of motor transportation and improvement of rural roads.

BARLEY AND BARLEY MALT.

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BARLEY AND BARLEY MALT.

SUMMARY AND CONCLUSIONS.

Tariff legislation of the past with respect to barley has been based almost entirely upon its use for malting purposes, in connection with the manufacture of fermented and distilled liquors. This market, formerly by far the most important outlet for the commercial crop, has been greatly reduced by prohibition legislation. In consequence, trade and producing conditions have greatly altered, and with them the tariff situation has changed.

A greatly reduced domestic market still exists for barley malt, chiefly in nonintoxicating malt beverages; and a small use is made of barley in various malt preparations and foods, barley flour, and pearled barley. But it is as a feedstuff, largely on the farms on which it is grown, that the great bulk of the barley crop is now consumed. In this use foreign competition can not be severe, because of the difference between farm and market values, costs of hauling, and the availability of substitute feedstuffs. The future of barley culture within the United States is chiefly dependent upon this growing farm consumption in regions where corn production is not profitable—that is, in the Pacific States and in the regions to the north and west of the corn belt. A considerable proportion of the crop is exported, and some quantities are fed to stock in urban centers. With respect to the principal outlets, for stock feeding or for export, American import duties on barley are of little significance.

In the crop or fiscal year 1915–16, which may be taken as representative of former conditions, the shipments out of producing counties (which roughly measure the commercial crop) amounted to 98,965,000 bushels, or 43.2 per cent of the harvest, of which over 27,000,000 bushels were exported. Of the 1919 crop, only 34.8 per cent, or 57,705,000 bushels, were shipped out of counties where grown, of which over 32,000,000 bushels were exported. The balance of 25,000,000 bushels, or about 15 per cent of the crop, roughly represents the domestic market for barley in malt beverages, sirups, various barley preparations, flour, and barley sold for feeding purposes. This is about one-third of the domestic market in 1915–16. It remains to be seen whether the two chief commercial outlets (as distinct from the farm consumption) will continue in their present dimensions—that is, the large export trade in barley and malt, which

is in part a war development, and the present somewhat uncertain market for barley malt in nonintoxicating malt beverages and sirups.

Between 1886 and 1890 there were imported annually from 10,000,000 to 11,500,000 bushels of barley, almost exclusively from Ontario and Quebec. The tariff of 1890, which raised the import duty on barley from 10 to 30 cents per bushel, made barley production in eastern Canada less profitable. Production declined, and exports to the United States virtually ceased. Indirectly, the prohibitive import duty gave a stimulus to barley production in the upper Mississippi Valley, and in the Pacific States. But the great increase in the American barley production within the past 15 years has been chiefly due to its increasing use as a feedstuff, primarily on the farms where it is grown, and in smaller measure to the development of an export trade in Pacific coast barley. The domestic crop is raised chiefly in California, the Dakotas, Wisconsin, and Minnesota.

Owing to the character of the soil and climate of Ontario and Quebec, the barley grown in those Provinces is especially adapted to the needs of maltsters. But most of the Canadian crop is now raised in the western Provinces, whose barley is considered by American maltsters to be a feeding grade. It is largely consumed in Canada as a feedstuff, or is exported to Europe. In the cost of producing barley in the United States and Canada there is scarcely any difference.

The Canadian import duty of 15 cents a bushel and the American duties of 30 cents (act of 1890), 30 per cent ad valorem (act of 1894), 30 cents (act of 1897), and 15 cents (act of 1913) have been almost prohibitive.

In the 17-year period 1900–1916, by far the greater portion of the American exports consisted of barley grown in the Pacific States (chiefly in California) which produce a grade of brewing barley preferred by European brewers. Only in the four fiscal years 1905, 1906, 1913, and 1916 was more than one-half of the exported grain shipped from the customs districts of the Atlantic coast. In nearly all of the remaining 13 years of the period 1900–1916, the exports from Atlantic and Gulf ports were insignificant. Despite high costs of transportation, Pacific barley is also shipped by water to the Atlantic markets, especially in years when the crop east of the Rockies is small or poor in quality.

In the case of California barley the prima facie evidence is that the American import duty has had no appreciable effect upon the domestic price. It is true that the Atlantic markets receive some quantities of this barley. But it is an "export" type, and from 5 to 25 per cent of the California crop is regularly exported. The States east of the Mississippi, however, constituted a deficiency sec-

ion, and the surplus of the Upper Mississippi Valley was frequently nsufficient to supply the eastern demand for the better grades of nalting barley. By virtue of the American import duties, in the ace of a strong malting demand, the producers of malting barley n the Northern States (principally Minnesota, Wisconsin, and the)akotas) have been able to secure a higher price for their grain. Chey received a greater benefit from the duty of 30 cents than they ould have received had the duty been 15 cents.

It is impossible to estimate the precise amount of benefit that the American producers of malting barley have derived from import luties. In the period 1907–1913, when the American import duty vas 30 cents per bushel, Milwaukee prices were generally from 10 o 30 cents higher than the Winnipeg quotations for barley in store t Fort William or Port Arthur; in the subsequent period, under the 5-cent duty, Milwaukee prices remained on a higher level, but the price disparity was materially reduced. Price comparisons for Buffalo and Toronto show a similar relationship. Under complete freedom of trade the Milwaukee price, for comparable grades, might till exceed Winnipeg quotations by the cost of transportation—not nore than 6 or 7 cents. In the period 1907 to 1916, the Milwaukee price would have been lower and the Winnipeg price higher. And it is probable that the decline in the Milwaukee price would have been greater than the advance in the Winnipeg price. This conclusion is based upon the fact (1) that much of the Canadian barley is suitable for malting purposes, and it could easily be transported to he chief brewing and malting centers of this country; (2) that by virtue of the higher American price, most of the barley exported from Canada would have been diverted to American markets; and (3) that the total barley exports and barley production of Canada would have been larger. It should be noted, however, that not all of these influences would be in active operation over short-time periods. It might require several years of free trade before the competition from Canada would be greatly increased. But in the ong run free trade would stimulate Canadian production and exports just as the American import duties have retarded them.

CHANGES IN USES AND MARKETS.

American barley production and trade is undergoing a period of readjustment incident to new and changing markets. The requirements of the brewing industry have dominated the character and conditions of barley culture in the United States. This market, it need hardly be said, has been greatly affected by recent adverse legislation, and in consequence the whole situation with respect to the tariff has been altered. Other commercial uses—the manufacture

of pearl or patent barley, breakfast foods, malt and flour preparations—have consumed a relatively small share of the crop. The preference of the domestic maltsters, who formerly consumed the great bulk of the better grades, is for a product that is uniform, well matured, of good color, free from weather damage, mold, or thrashing injury, and of high germinating power. Lower grade barleys and the excess over the manufacturing and export demand have been used as a stock feed, chiefly on the farms where they were raised and to a small extent in urban centers. While the domestic use of barley for malting purposes has greatly declined, the farm consumption has been growing steadily, both in absolute and relative figures. Thus the percentage "shipped out of counties where grown," which approximately represents the commercial crop, declined from 57.2 per cent of the 1911 harvest to only 34.8 per cent of the harvest of 1919,[1] and more than half of this commercial supply is exported.

It is therefore to an increasing use of barley for stock feed, on the farms where it is grown, and to the great increase in the export trade that the maintenance of production since 1909 is to be ascribed, and with respect to these outlets American import duties on barley have but little significance. As a feedstuff barley has a value not far below that of corn, for which it is the principal grain substitute in regions lying to the north and west of the corn belt. Elsewhere it must meet the competition of corn and oats. West of the Rockies it is the principal grain feed; in the Great Plains region likewise it promises to fill the needed place as a live-stock feed in the transition from grain growing to mixed farming.

PROHIBITION AND THE TARIFF.

In connection with the import duties on barley, it is important to recognize at the outset the character of the several outlets for the domestic production. The tariff controversy has related entirely to barley for malting purposes, which has been the most profitable outlet for the commercial crop. Malting barley of the better grades was once one of the chief imports from Canada. But this market, which had been progressively narrowed by the spread of local option and prohibition in individual States, was more radically affected by Federal legislation toward the close of the World War.

PRESENT OUTLETS FOR DOMESTIC BARLEY.

So far as concerns the present domestic consumption of barley malt, there remain only the small but increasing market afforded by

[1] Monthly Crop Report, U. S. Department of Agriculture, March issues.

the change in the uses of domestic barley is the fact that the commercial crop of 1919—the "shipments out of counties where grown"—constituted only 57,705,000 bushels (as compared to 98,965,000 bushels in 1915); and of this amount there were exported during the first nine months of the crop year 1919 about 32,000,000 bushels. Thus the domestic market for barley, in all uses other than the farm consumption, was reduced to around 25,000,000 bushels, or about 15 per cent of the harvest of 1919 (165,719,000 bushels); this is about one-third the dimensions of the domestic market in the year 1915–1916.

TABLE 1.—*Approximate disposal of the barley crop of the United States, 1915–1916.*

	Bushels.	
Barley crop, year 1915–16		228,851,000
Used in the manufacture of fermented and distilled liquors, fiscal year 1915–16:		
In fermented liquors,[1] 57,683,970 bushels malt, equivalent to bushels of barley	52,439,920	
In distilled liquors,[2] 4,480,588 bushels malt, equivalent to bushels of barley	4,073,258	
		56,513,178
Ground in "flour and grist mills," census of 1914 (chiefly for feeding purposes)		20,288,396
Fed on farms[3] (rough estimate made by crop correspondents of the Department of Agriculture in the year 1914), 47 per cent		107,560,000
Exports		27,473,160
Unaccounted for[3] (patent or pearl barley, yeast and vinegar, breakfast foods, malt preparations, also amounts fed in urban centers)		17,016,266
"Shipped out of counties where grown" (the commercial crop less a comparatively small quantity sold locally), 43.2 per cent		98,965,000
Not "shipped out of counties where grown" (the farm consumption plus local sales), 56.8 per cent		129,886,000

TARIFF PROVISIONS WITH RESPECT TO BARLEY AND BARLEY MALT.

Under the tariff act of 1883 the import duty upon barley was 10 cents per bushel; in 1890 it was raised to 30 cents, at which rate it was maintained (except for the period 1894–1897) until the enactment of the act of October 3, 1913. It was there reduced to 15 cents. Upon barley malt the 1913 act reduced the 45-cent rate existing since 1890 (except 1894–1897) to 25 cents. As 1 bushel of barley will

[1] Monthly Crop Report, U. S. Department of Agriculture, November, 1918, p. 135 Compiled from returns made by brewers to the Internal Revenue Service.

[2] Annual reports, Internal Revenue Service.

[3] Monthly Crop Report, U. S. Department of Agriculture, October, 1914. Estimates of the quantities fed on farms were doubtless higher than 47 per cent in 1915, when the largest crop recorded up to that time was harvested; and the difference would probably take in the larger part of the quantity "unaccounted for."

yield about 1.1 bushels of malt, the domestic maltsters have throughout enjoyed a material protection apart from the compensatory duty upon barley.

Import duties of the United States upon barley, barley malt, and other barley products, 1883–1913.

Tariff act. Year.	Tariff act. Paragraph.	Tariff classification or description.	Rate of duty.
1883	260	Barley, per bushel	10 cents.
	262	Barley malt, per bushel of 34 pounds	20 cents.
	261	Barley, pearled, patent, or hulled, per pound	½ cent.
1890	252	Barley, per bushel of 48 pounds	30 cents.
	253	Barley malt, per bushel of 34 pounds	45 cents.
	254	Barley, pearled, patent, or hulled, per pound	2 cents.
1894	191	Barley	30 per cent ad valorem.
	191	Barley malt	40 per cent ad valorem.
	191	Barley, pearled, patent or hulled	30 per cent ad valorem.
1897	223	Barley, per bushel of 48 pounds	30 cents.
	224	Barley malt, per bushel of 34 pounds	45 cents.
	225	Barley, pearled, patent or hulled, per pound	2 cents.
1909	230	Barley, per bushel of 48 pounds	30 cents.
	231	Barley malt, per bushel of 34 pouuds	45 cents.
	232	Barley, pearled, patent, or hulled, per pound	2 cents.
1913	188	Barley, per bushel of 48 pounds	15 cents.
	189	Barley malt, per bushel of 34 pounds	25 cents.
	190	Barley, pearled, patent, or hulled, per pound	1 cent.

WORLD PRODUCTION AND TRADE.

In many parts of Europe, in the Orient and North Africa, barley is extensively used as a bread grain. In Great Britain and Northern Europe it also takes the place of corn for stock feeding. During 1909–1913 the world's barley harvest averaged 1½ billion bushels. Europe produced 1 billion bushels (chiefly in Russia, Germany, Austria-Hungary, Spain, France, and the United Kingdom); Asiatic Russia, about 150,000,000 bushels; Japan, 90,000,000 bushels; the United States, 182,000,000 bushels, or 12 per cent; and Canada 49,000,000 bushels. During the same period about 265,000,000 bushels,[2] or about 18 per cent of the world crop, entered into international commerce. It was largely an intra-European trade, only about 37,000,000 bushels being exported from British India, the United States, Algeria, and Canada. Of the world exports, Russia shipped more than one-half, while Germany received over 50 per cent and the United Kingdom 25 per cent.

PRODUCTION IN THE UNITED STATES.

Producing sections.—Economic and physical limitations restrict the areas of profitable barley culture to regions lying for the most part to the north and west of the corn belt. Among such limitations

[2] Net exports. Figures are from Yearbooks of U. S. Department of Agriculture.

are the preference of the crop for a cool climate, its sensitiveness to soil conditions, the competition of corn and oats for stock feeding, and of these and other products as "cash crops." Moreover, the warm and humid summers which characterize a large part of the United States are unsuitable to the production of the best grades of barley.

But in the favorable regions barley production has made rapid progress. Between 1870 and 1912 the national production increased nearly ninefold—1870, 26,295,000 bushels; 1890, 67,168,000 bushels; 1912, 223,824,000 bushels. Since 1909 the acreage has on the whole remained stationary, although the crop has undergone a considerable geographic redistribution.

The two chief barley-producing sections of the United States are now the extreme West, especially California, and the upper Mississippi Valley States—Minnesota, the Dakotas, and Wisconsin. In each of these sections a predominant commercial type is grown; and these types enter into a distinct trade. The market price depends in part on their suitability to the use to which they are put. The six-rowed California Feed or Bay Brewing barley is known as an "export" type, being preferred by European brewers. The brewers of the Central and Eastern states used chiefly the Manchuria and Oderbrucker varieties grown in the northern Great Plains. For pearled barley is used a large-grained, two-rowed variety known as "Chevalier"; this type is grown under irrigation in Montana and in the delta lands of California.[8]

Usually California produces more barley than any other single State, but the chief center of production is located in the group of North Central States, which in 1919 contained nearly one-half the total area in barley. Other important barley-producing States in the Mississippi Valley are Iowa, Nebraska, and Kansas; in the West, Washington, Oregon, Idaho, Montana, and Colorado; east of the Mississippi, in Michigan and New York. Of the 57,705,000 bushels shipped out of the producing counties in 1919, California contributed 16,500,000 bushels and the States in the upper Mississippi Valley about 34,000,000 bushels. These regions and New York usually produce better malting barley; elsewhere feed barley is more generally grown. The acreage, production, and yield per acre for the United States since 1902 are shown in Table 2.

[8] Farmers' Bul. No. 968, U. S. Department of Agriculture.

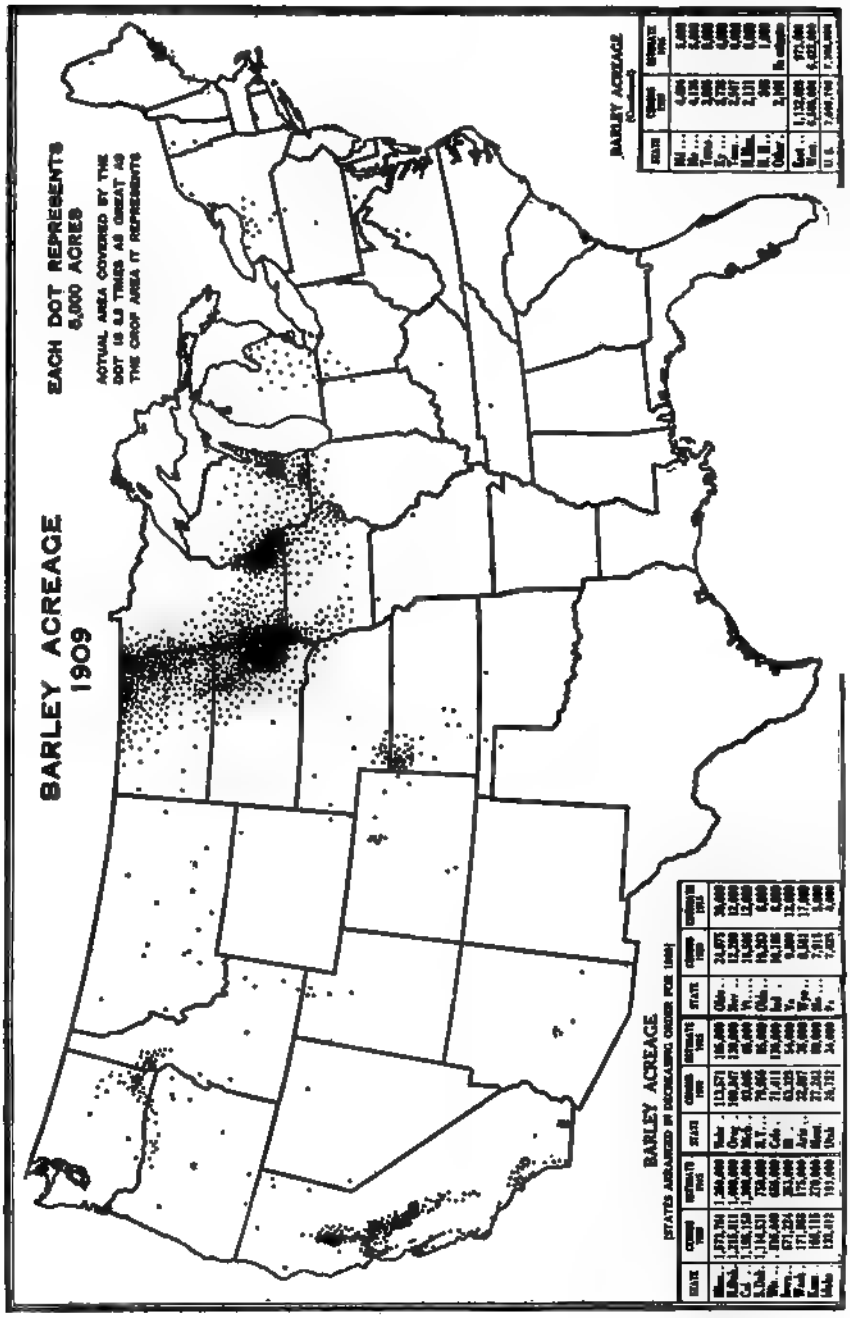

BARLEY ACREAGE
1909
EACH DOT REPRESENTS
5,000 ACRES
ACTUAL AREA COVERED BY THE
DOT IS 5.3 TIMES AS GREAT AS
THE CROP AREA IT REPRESENTS
BARLEY ACREAGE
STATES ARRANGED IN DECREASING ORDER FOR 1909
BARLEY ACREAGE

TABLE 2.—*Acreage, production, and yield per acre of barley in the United States, 1902–1920, and in Canada, 1908–1920.*

[Figures for the United States are from the Yearbooks of the Department of Agriculture; for Canada, from the Canada Yearbooks.]

Year.	Acreage.		Production.		Average yield per acre.	
	United States.	Canada.	United States.	[illegible]	United States.	Canada.
	Acres.	*Acres.*	*Bushels.*	*Bushels.*	*Bushels.*	*Bushels.*
1902	[illegible] 00		[illegible] 00		29.0	
1903	00		00		26.4	
1904	00		00		27.2	
1905	00		00		26.8	
1906	00		00		28.3	
1907	00		00		23.8	
1908	00	1,745,700	00	46 00	25.1	26.79
1909	00	1,8[illegible] 00	00	55 00	22.5	29.71
1910	00	1,2 11	00	28 35	22.5	22.42
1911	00	1,5 94	00	44 00	21.0	29.19
1912	00	1,5 00	00	45 00	29.7	31.24
1913	00	1,6 00	00	46 00	23.8	20.96
1914	00	1,4 00	00	36 00	25.8	24.21
1915	00	1,7 32	00	54 00	32.0	31.51
1916	00	1,8 96	00	42 00	23.5	23.72
1917	00	2,3 00	[illegible] 00	58 50	23.7	23.00
1918	00	3,1 00	256,225,000	77 00	26.5	24.50
1919	00	2,6 00	165,719,000	56 00	22.3	21 3
1920[1]	00	2,5 00	191,386,000	65 00	.....	.....

[1] Preliminary estimates.

Westward movement of barley production.—Prior to 1890 New York was of much greater importance as a barley-producing State than it is to-day. According to the testimony of maltsters in former tariff hearings,[4] the barley grown in the Northeast, although of not so good a quality, was mixed with the high-grade barley imported from Canada and used in the manufacture of malt. In this industry New York led all the States. The principal malting centers were Buffalo and Oswego, located within easy access of both sources of supply. The tariff legislation of 1890, however, raised the duty on barley from 10 to 30 cents a bushel, thereby causing a marked diminution in the importation of the grain. With the supply of Canadian barley virtually cut off, and in the face of competition from other types of agriculture as well as of western barleys, the center of the malting industry moved westward to Milwaukee, Chicago, St. Louis, and Minneapolis.

The westward movement of barley cultivation is indicated in Table 3, showing the acreage and production of the principal States at 10-year intervals since 1889.

[4] Tariff Hearings, Committee on Ways and Means, 62d Cong., 3d sess., 1913, p. 2665 et seq. Also S. Doc. No. 56, vol. 1, p. 582.

TABLE 8.—*Acreage and production of barley in the United States, by principal States, 1889–1919.*

[From Yearbook, U. S. Department of Agriculture, 1918; and Thirteenth Census.]

ACREAGE.

State.	1919	1909	1899	1889
United States	7,420,000	7,668,706	4,170,196	3,220,[illegible]
New York	113,000	79,956	111,658	249,[illegible]
Minnesota	910,000	1,573,761	577,845	258,[illegible]
North Dakota	1,300,000	1,215,811	287,092	109,[illegible]
South Dakota	875,000	1,114,531	208,510	97,[illegible]
Kansas	600,000	166,115	119,158	7,[illegible]
Iowa	315,000	571,224	627,851	515,[illegible]
Colorado	200,000	71,411	21,949	12,[illegible]
Oregon	82,000	108,847	60,375	37,[illegible]
California	1,000,000	1,196,158	1,029,647	815,[illegible]
Wisconsin	512,000	516,449	555,747	474,[illegible]
Michigan	280,000	98,055	44,965	99,[illegible]

PRODUCTION (BUSHELS).

United States	166,719,000	178,344,212	119,694,877	78,332,[illegible]
New York	2 00	1 88	2,943,250	6,220,[illegible]
Minnesota	18 00	34 73	24,314,240	9,100,[illegible]
North Dakota	14 00	26 58	6,752,080	1,570,[illegible]
South Dakota	19 00	22 80	7,081,760	902,[illegible]
Kansas	16 00	2 16	1,474,150	165,[illegible]
Iowa	8 00	10 84	18,060,060	13,406,[illegible]
Colorado	2 00	1 42	531,240	331,[illegible]
Oregon	1 00	2 35	1,515,150	874,[illegible]
California	30 00	26 64	25,149,335	17,548,[illegible]
Wisconsin	12 00	23 41	15,699,690	15,225,[illegible]
Michigan	5 00	2 01	1,165,288	2,523,[illegible]

PRODUCTION IN CANADA.

In Canada the production of barley has not increased so rapidly as in the United States. In 1871 the total production was 11,496,000 bushels; in 1891, 17,222,000 bushels, and in 1910, a short-crop year, 28,846,000 bushels. In 1918, a record year in Canada, 77,287,000 bushels (a little over one-fourth the American crop) were produced on 2,646,000 acres. In the decade prior to 1916 the acreage in barley was almost stationary, but it has since increased considerably. The acreage, production, and yield per acre for Canada as a whole since 1908 are shown in Table 2, and by Provinces since 1890, in Table 4.

Formerly the most important barley-producing Province was Ontario, but from 1890 to 1915 its acreage materially declined, while its production remained around 15,000,000 bushels. This Province, together with Quebec (producing between 2,000,000 and 3,000,000 bushels annually), has long been noted for its excellent barley. Before 1890 large quantities of the grain were exported from eastern Canada to the United States, where it was converted into malt.

Most of Canada's barley is now raised in the prairie Provinces, where its production has rapidly increased. In 1919 these three Provinces harvested 41,000,000 bushels, of which Manitoba, the principal producer, grew over 18,000,000 bushels. By American maltsters

"Manitoba" barley, or the barley of western Canada, is considered to be a feeding grade, though it is in demand in England for brewing purposes. The early maturity of barley, its usefulness as a "catch crop" and as a means of keeping down weeds, its value in more northern regions as a substitute for corn—such factors are doubtless increasing the acreage in Canada. There it is sometimes grown as the first crop on newly broken sod, though a coarse grade of barley results. Frost damage, affecting its germinating power, frequently renders this barley unavailable for malting purposes.

TABLE 4.—*Acreage and production of barley in Canada, by Provinces, 1891–1919.*

[From Canada Yearbooks and Census and Statistics Monthly.]

ACREAGE.

Province.	1919	1917	1915	1910	1901	1891
Canada	2,645,509	2,392,200	1,509,350	1,286,611	871,800	868,464
Quebec	234,892	165,600	85,000	101,728	104,135	94,464
Ontario	569,183	361,000	449,000	503,129	586,010	681,073
Manitoba	896,947	708,000	490,000	416,016	139,672	56,505
Saskatchewan	492,586	669,900	287,000	129,621	22,897	8,467
Alberta	414,212	472,100	185,000	121,435		
All other	40,689	15,600	13,350	14,682	19,086	27,955

PRODUCTION (BUSHELS).

Canada	58,336,000	55,057,350	53,331,300	28,846,425	22,224,366	17,222,795
Quebec	5,237,000	3,063,600	2,255,000	2,378,372	2,535,597	1,580,197
Ontario	13,803,000	11,191,000	15,369,000	14,055,327	16,087,862	13,419,354
Manitoba	18,326,000	15,930,000	17,763,000	6,506,634	2,666,803	1,452,433
Saskatchewan	9,236,000	14,067,900	10,570,200	3,061,007	474,554	215,460
Alberta	10,562,000	10,386,200	6,984,000	2,480,165		
All other	1,172,000	419,050	390,100	364,920	459,550	555,351

The yield of barley per acre is slightly larger in Canada than in the United States (see Table 2). In the period 1908 to 1919, inclusive, the average yield per acre in this country was 24.9 bushels, compared with an average yield in Canada of 25.7 bushels. Except in California, the yield in the important barley-producing Provinces of Canada is clearly above that of the chief barley sections in this country, but there is not the striking difference in productivity that is found when comparing the yield of wheat, oats, flaxseed, and potatoes in the two countries.

TRADE OF THE UNITED STATES AND CANADA.

Reference has already been made to the fact that prior to 1890 large quantities of Canadian barley were regularly imported into the United States (See Table 5) where it was mixed with the barley of the Northeast and used in the manufacture of malt. In New York State the malt industry became well established. Under the import duty of 10 cents a bushel (reduced from 15 cents by the act

of 1883) the amount of Canadian barley used by the malt manufacturers ranged annually from 8 to 11 million bushels. At the same time the duty upon barley malt was fixed at 20 cents—a prohibitive differential. Most of the imported grain entered the United States at Buffalo and Oswego. In 1890, for instance, 3,196,400 bushels were entered at Buffalo, 3,303,956 bushels at Oswego, and 2,386,117 bushels at Niagara. In 1882, when over 12,000,000 bushels were imported 4,449,400 bushels entered at Oswego, 1,997,008 bushels at Buffalo, 1,207,486 bushels at Detroit, and 1,456,865 bushels at the Lake Huron ports of Michigan.

TABLE 5.—*Trade in barley and barley malt: United States and Canada*

	Bushels.	*Bushels.*	*Bushels.*	*Bushels.*			*Bushels.*
1880		[illegible]35,258	1,128,923	14,781	35	62	[illegible]
1881		28,616	885,246	16,742	33	79	[illegible]
1882		22,722	205,930	9,410	91	1 46	[illegible]
1883		20,687	433,005	16,426	55	16	[illegible]
1884		26,122	724,955	28,033	93	62	[illegible]
1885		28,507	620,130	14,672	17	95	[illegible]
1886		27,115	252,183	8,134	12	02	53,69[illegible]
1887		55,594	1,305,300	5,053	53	64	
1888		11,461	550,884	6,777	56	58	
1889		18,414	1,440,321	8,581	53	07	
1890		22,545	1,408,311	12,217	50	08	
1891		76,733	62	149	97	27	
1892		16,328	75	1,528	34	93	
1893		70,129	67	5,195	15	48	
1894		21,061	05	3,165	20	05	
1895		26,816	54	10,223	72	70	
1896		37,384	31	46,946	00	28	[illegible]
1897		1,271,787	01	12,594	85	1,831,094	280,5[illegible]
1898		124,804	77	103,028	03	443,656	405,70[illegible]
1899		110,475	03	140,317	37	238,948	453,0[illegible]
1900		189,757	62	443,620	05	2,158,282	296,7[illegible]
1901		171,004	07	66,276	22	2,386,371	357,9[illegible]
1902		57,406	68	8,041	29	457,117	401,3[illegible]
1903		56,462	41	1,525	09	[illegible]12	347,[illegible]
1904		90,708	27	847	55	70	636,5[illegible]
1905	80,332	81,020	55	964,664	88	08	457,1[illegible]
1906	17,053	18,049	60	1,923,755	96	28	851,5[illegible]
1907 [7]	37,171	38,319	42	442,118	71	30	414,5[illegible]
1908	198,118	199,741	78	62,572	74	44	224,9[illegible]
1909	2,420	2,644	93	204,261	59	35	163,2[illegible]
1910	(8)	[8] 3,969	86	164,532	99	01	156,[illegible]
1911	(8)	[8] 186,247	46	155,564	96	53	117,[illegible]
1912	(8)	[8] 2,788,474	42	7,884	99	07	76,0[illegible]
1913	(8)	[8] 5,524	03	111,954	25	75	370,9[illegible]
1914	(8)	[8] 339,085	47	642,920	00	1 69	330,6[illegible]
1915	(8)	[8] 98,532	22	1,076,228	40	46	2,153,0[illegible]
1916	(8)	[8] 37,231	60	32,943	53	73	3,652,2[illegible]
1917	(8)	459,446	77	2,633	38	27	4,331,7[illegible]
1918	(8)	509,840	78	1,366	88	90	2,674,[illegible]
1919	(8)	17,239	[illegible],81	1,731	31	64	3,993,0[illegible]
1920 [9]		332,546	26,671,284	21,944	44	1 82	8,594,2[illegible]

[1] From The Foreign commerce and Navigation of the United States, fiscal years ending June 30.
[2] Annual reports of the Canadian Department of Customs on Trade and Navigation. From 1880–1906 fiscal years ending June 30; after 1906, Canadian fiscal years ending March 31.
[3] Canadian exports and imports of barley malt and American imports of barley malt are unimportant
[4] Not given separately.
[5] Canadian figures in 1907 are for 9 months.
[6] Imports for consumption beginning 1910, figures for general imports not being separately stated after 1909.
[7] Preliminary figures

Following the tariff legislation of 1890, which raised the duty on barley to 30 cents a bushel, imports rapidly declined and, after 1897, became insignificant in amount. The new duty virtually cut off the supply of high-grade Canadian barley, and the maltsters were obliged to look to the grain-growing States of the northern Mississippi Valley for their raw material. In New York and other eastern States the malt industry declined in importance, while in Illinois, Wisconsin, and Minnesota it received a fresh stimulus. In 1890 there were 82 malting establishments in New York State, with a total product valued at $9,865,000. In 1905 the number of establishments had fallen to 43 and the total value of their products to $7,037,000. During the same period the number of establishments in Wisconsin increased from 15 to 29 and the value of their products from $2,472,000 to $8,740,000 (see Table 6). It should be noted that in those States where there was a decline in the number of malting establishments or in the value of their production, the fact of a decrease can not be taken in all cases as indicating the actual decrease of the industry, for the reason that a large number of the principal brewers in the United States made their own malt, and this practice probably prevailed more generally in 1905 than in 1890. In New York State, however, the decline of the industry was not only relative but absolute.

TABLE 6.—*Production of malt in the United States, by States, 1890, 1900, 1905, and 1914.*

[From United States Census of Manufactures.]

State.	Number of establishments.				Value of product.			
	1890	1900	1905	1914	1890	1900	1905	1914
California	7	5	5	3	$552,872	$582,990	$660,349	$938,000
Illinois	23	14	21	14	4,802,959	5,135,990	8,539,870	11,133,000
Indiana	.....	.....	3	.....	.....	.....	52,150	.....
Iowa	6	.....	.....	.....	226,477	.....	.....	.....
Kentucky	5	3	.....	.....	508,290	203,713	.....	.....
Maryland	3	.....	.....	.....	395,517	.....	.....	.....
Michigan	7	4	4	.....	632,919	741,436	544,599	.....
Minnesota	.....	5	7	9	.....	241,932	1,197,639	5,637,000
Missouri	11	9	6	.....	725,924	313,803	367,478	.....
New York	82	57	43	25	9,865,738	5,918,025	7,037,043	12,381,000
Ohio	22	14	7	5	1,926,496	1,166,268	1,135,725	771,000
Pennsylvania	13	8	7	4	829,297	452,765	815,779	100,000
Wisconsin	15	17	29	25	2,472,018	4,089,715	8,740,103	15,583,000
All other States	8	10	9	12	504,052	526,963	1,198,249	1,640,000

While the production of barley in the eastern States declined, probably through the operation of the same forces that caused the westward shift of grain production, there was a notable increase in the production of the States to the west. In the northern part of the Mississippi Valley is produced barley capable of producing malt of high diastatic power, somewhat similar to that of Ontario. In part,

the duty was directly responsible for the increase in barley production; it effectively prevented the importation of several million bushels every year. But for the most part the more recent increases in production were due to the larger use of barley as a stock feed, in regions where corn production is unprofitable.

Exports of barley have greatly increased since 1890, while imports have become insignificant (see Table 5). During the decade, 1900 to 1910, exports were almost as large as imports for the decade, 1880 to 1890. In Canada, however, the tendency prior to the World War was in the opposite direction. From 1890 to 1912 exports greatly declined and imports, coming almost entirely from the United States, tended to increase. Clearly, the effect of the American import duty after 1890 was to deprive Canada of her most important foreign market and to make the production of barley less profitable. In Ontario and Quebec, then the principal barley-producing Provinces, farmers began to give more attention to other products.

Notwithstanding the fact that brewers and maltsters of the Central and Eastern States have constantly complained of the scarcity of high-grade barley, a large portion of the barley exports from the United States consists of malting barley. This peculiar condition has arisen from the unfavorable location of the chief malting centers with respect to the barley-producing areas of the extreme West. Barley of the type preferred by European brewers is now grown in the far western States, particularly California, too far distant from the malting centers of the East and Middle West to permit the transportation of the grain by rail except in years when the price becomes exceedingly high. European brewers generally prefer barleys that yield malt of lower diastatic power, i. e., of low nitrogen but high starch content. American brewers generally favored barley of the opposite characteristics (of the type grown in the upper Mississippi Valley); such malt was mixed with other cereals, principally corn grits, and was used particularly for clear bottle beers. Accordingly, much of the crop of the Pacific States is exported, chiefly to Great Britain.[7] And it is this far western barley that maintains the export trade. Since 1900, in each year when exports have been less than 10,000,000 bushels, by far the greater part of the barley exports of the United States have been made from the customs districts of the Pacific coast. In 1901, for instance, barley exports from the Pacific coast (chiefly from San Francisco) represented 78 per cent of the whole; in 1902, 97 per cent; in 1903, 92 per cent; in 1904, 97 per cent; in 1907, 80 per cent; in 1908, 91 per cent; in 1909, 92 per cent; in 1910, 90 per cent; in 1911, 97 per cent; in 1912, 92 per cent; in 1914, 86 per cent; and in 1915, 73 per cent.

[7] The preference of European buyers was forcibly shown in the crop year 1919–1920, when many Pacific Coast dealers exported the local barley and brought in for feeding purposes considerable quantities of Eastern barley.

Thus much of the barley of the United States is ordinarily not available for the principal malsters and brewers in the interior, on account of the costs of rail transportation. But within recent years large quantities of Pacific Bay Brewing barley were shipped by water, or by rail and water, to the Atlantic seaboard. By changing their methods Eastern maltsters were able to use this grain with excellent results. In the years 1906 and 1913, however, more than 17,000,000 bushels were exported from the United States and most of the grain passed through Atlantic rather than Pacific ports. These exports were made on account of unusually large crops, which temporarily reduced the price in eastern markets to an export basis. But in normal years only the barley grown in the extreme West is regularly on an export basis. The significance of this fact will be readily apparent when studied in connection with barley prices.

TABLE 7.—*Exports of barley from the United States, by customs districts, 1905–1919.*

[From Foreign Commerce and Navigation of the United States.]

Year.	Atlantic ports.	Gulf ports.	Mexican border.	Pacific coast ports.	Northern border.	Total.
	Bushels.	*Bushels.*	*Bushels.*	*Bushels.*		*Bushels.*
1905	4,041,636	321	57,131	5 [illegible]10	57	10,661,655
1906	11,353,001	1,364,352	101,317	2 16	74	17,729,360
1907	1,088,721	15,192	229,382	6 16	31	8,238,842
1908	25,396	20	360,332	3 46	84	4,349,078
1909	209,256	10	162,512	9 95	16	6,580,393
1910	154,275	25	99,210	3 31	75	4,311,568
1911		6	162,533	9 52	55	9,399,346
1912	156	6	126,129	1 90	561	1,585,242
1913	10,126,580	154,377		6 26	177,626	[1]17,536,703
1914	860,296			5 05		[1]6,644,747
1915	6,776,134	10,169	47,484	10 89	255,946	25,754,522
1916	16,860,057	155,574	98,451	10 49	109,229	27,473,190
1917	11,194,706	[2]2,080,408	10,738	2 16	309,909	16,381,077
1918	7,040,463	18,200,408	59,991	82	498,556	26,285,378
1919	14,456,612	1,905,960	55,065	3 26	289,899	20,457,781
1920	12,212,867	8,728,709	44,242	2 50	2,882,522	26,671,284

[1] Includes "all other" districts, 283,294 in 1913 and 54,845 in 1914.
[2] The Gulf shipments during 1917 and 1918 consisted almost entirely of California barley.

COMPARATIVE PRICES.

Grades and markets.—The only quotations that can be used for comparative study are those of the western markets, Winnipeg (for barley in store at Fort William and Port Arthur) and Milwaukee.[3]

[3] In Buffalo, the standard quotation is for "malting barley." Owing to the wide range in the quality of barley that may be used for malting, there is much variation in prices of the grain that falls within this grade. In the Toronto market the standard quotation is for No. 2 Ontario. As defined by the Canadian inspection and sales act, barley of this grade "shall be reasonably clean and sound, but not bright and plump enough to be graded as No. 1, and shall be reasonably free from other grain, and weigh not less than 48 pounds to the bushel." Report of the Canadian Department of Labor on "Comparative prices Canada and the United States," 1911, p. 13. The absence of a definite standard in the Buffalo market renders impossible any careful comparison of barley prices in Buffalo and Toronto. Likewise, Chicago quotations are valueless for the present purpose, because in that market, as in practically all other markets, barley is sold by sample and the quotations present a wide range from feed to best malting.

Both markets are prominent in the barley trade, and the kind of barley for which the quotations are given is used in the manufacture of malt. It must be noted, however, that Manitoba barley, even though it sometimes sells at a premium in the British markets, is not, like the barley of Ontario, highly regarded by the American maltsters. But a comparison of Toronto and Buffalo prices shows substantially the same relationship as exists between Winnipeg and Milwaukee quotations. In Winnipeg the standard quotation is for No. 3 Western, which includes "shrunken or otherwise slightly damaged barley, weighing not less than 45 pounds to the bushel. In Milwaukee No. 3 barley includes "slightly shrunken or otherwise slightly damaged barley, not good enough for medium, and not scoured nor clipped," weighing not less than 44 pounds to the measured bushel.* In both countries, however, sales are by weight, upon the basis of a bushel of 48 pounds.

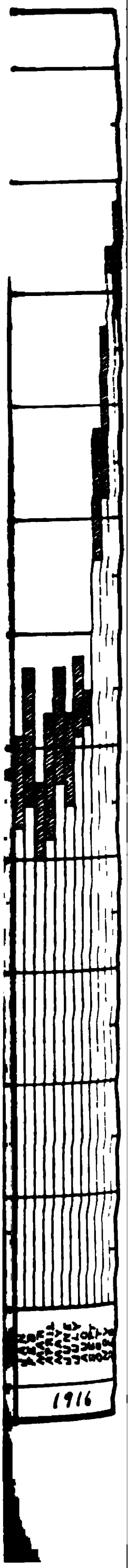
In considering the effect of the import duty upon Milwaukee prices it should be borne in mind that the freight rates from the producing sections of the western Provinces were substantially the same to Fort William and Milwaukee, and that the lake freights between the two markets were from 1 to 3 cents per bushel. Consequently there is no occasion for a considerable and continuous disparity in the Winnipeg and Milwaukee quotations, for comparable grades, except in so far as they are caused by the import duties. It is true that Milwaukee is a great "cash" or consuming market, while Winnipeg is essentially a primary market; and that, by reason of car shortages, quick changes in market prices, and traffic congestion, "spot" stocks often command a considerable premium. But price differences arising from such causes seldom are long maintained. If barley of a given quality is regularly exported to Europe from certain sections of this country, as from California, it is obvious that the price of barley (of the same quality) in those sections is unaffected by import duties. On the other hand, if the price is too high to permit exportation, and is higher than the price in Canada by more than the cost of transportation, then it may be concluded that the import duty has affected the price.

Prices and import duties.—A comparison of the prices in the two markets during 1906 to 1916 (on the opening market day of each month) shows that the Milwaukee price exceeded the Winnipeg price 120 times for a total of 1,993¾ points, while the Winnipeg price exceeded the Milwaukee price 8 times for a total of 19¾ points. The results may be summarized in greater detail as follows:

* Fifty-ninth Annual Report of the Chamber of Commerce of the city of Milwaukee, p. 60.

REDUCING

reverse



	Number of times.
ıkee prices were higher	120
5 cents or less	21
more than 5 and less than 10 cents	18
10 to 20 cents	46
20 to 30 cents	18
30 to 40 cents	9
40 to 50 cents	2
50 to 60 cents	3
60 to 70 cents	3
ıpeg prices were higher	8
3y 5 cents or less	7
By more than 5 and less than 10 cents	1
es were the same in both markets	2
es were not comparable	2

The only year in which the prices in the two markets were on an approximate level was 1906, when, for a portion of the year, at least, the price of barley in Milwaukee was on an export basis. In that year a record crop was harvested in the United States and barley exports were unusually large, the shipments from the Pacific coast districts comprising only 15 per cent of the whole. In Canada there was a shortage of barley and nearly 2,000,000 bushels were imported from the United States. In all other years the Milwaukee price was well above the Winnipeg price, except for three scattered monthly quotations. Of the 120 times that the Milwaukee quotations exceeded those at Winnipeg, 46 times were for 10 to 20 cents, 18 times for 20 to 30 cents, and 17 times for more than 30 cents.[10]

The Milwaukee price frequently exceeded the Winnipeg price by the full amount of the duty (30 cents from 1897 to October 3, 1913, 15 cents per bushel thereafter). The greatest excess occurred during the crop year 1911–1912, as a result of a short American crop. The barley imports in that year (2,768,474 bushels) were greater than the combined imports of the preceding 15 years.

After the tariff legislation of October, 1913, which reduced the duty on barley from 30 to 15 cents a bushel, the Milwaukee price again exceeded the Winnipeg price by more than the full amount of the duty. In the subsequent period, when both the lake region and the Canadian west were exporting barley, the excess of the Milwaukee over the Winnipeg quotations was greatly reduced.

[10] No attempt will be made to compare Milwaukee and Winnipeg quotations with the quotations of the Liverpool market. In that market the receipts of Canadian and Mississippi Valley barley have been too small and irregular to make such comparisons possible; furthermore, there is the difficulty growing out of the lack of standardization in grades.

TABLE 8.—*Cash prices of barley in Winnipeg and Milwaukee on the opening market day of each month, and the advance of Milwaukee over Winnipeg prices, 1906–1916.*

Month.	1906			1907			1908			1909		
	Winnipeg.[1]	Milwaukee.[2]	Advance of Milwaukee over Winnipeg.	Winnipeg.	Milwaukee.	Advance of Milwaukee over Winnipeg.	Winnipeg.	Milwaukee.	Advance of Milwaukee over Winnipeg.	Winnipeg.	Milwaukee.	Advance of Milwaukee over Winnipeg
			Cents.			*Cents.*			*Cents.*			*Cents.*
January	$0.38	$0.38	.....	$0.42	$0.45	3	$0.46	$0.80	34	$0.49	$0.60	11
February	.39	.40	1	.42	.49	7	.56	.76	20	.48	.62	14
March	.39	.37	−2	.42	.61	19	.49	.74	25	.51½	.65	13½
April	.38	.37½	−½	.42	.63	21	.49	.64	15	.57½	.63	5½
May	.42	.40	−2	.44	.68	24	.50	.64	14	.57½	.65½	8
June	.42½	.44	1½	.44	.68	24	.45	.57	12	.57½	.73	15½
July	.43	.45	2	.54	.65	11	.44	.54	10	.58	.63	5
August	.42	.40	−2	.54	.52	−2	.47½	.57	9½	.58	.62	4
September	.37½	.38	½	.51	.78	27	.48	.61	13	.45½	.56	10½
October	.40	.38	−2	.69	.90	21	.54	.57	3	.45½	.56	10½
November	.42	.43	1	.62	.75	13	.51	.53½	2½	.46½	.56	9½
December	.42	.44	2	.50	.80	30	.46	.57	11	.46½	.60	13½

Month.	1910			1911			1912			1913		
			Cents.			*Cents.*			*Cents.*			*Cents.*
January	$0.45	$0.64½	19½	$0.47	$0.83½	36½	$0.59	$1.22	63	$0.45½	$0.61	15½
February	.48½	.66	17½	.49½	.87	37½	.67	1.27	60	.47½	.62	14½
March	.48	.68	20	.56	.85	29	.63	1.18	55	.46½	.59	12½
April	.47½	.63	15½	.65	.98	33	.65	1.25	60	.47½	.62½	15½
May	.44½	.60	15½	.69	1.00	31	.69	1.25	56	.48½	.58½	10
June	.42	.57	15	.....	.78	.....	.62	1.20	58	.47½	.63	15½
July	.50	.59½	9½	.60	.95	35	.58	.90	32	.47½	.61	13½
August	.47	.60	13	.59½	.83	23½	.51	.68	17	.46	.63	17
September	.47	.67	20	.72	1.08	36	.53½	.63	9½	.45½	.71	25½
October	.47	.69	22	.74	1.15	41	.50	.63	13	.45½	.72	26½
November	.47	.70	23	.66	1.07	41	.55	.62	7	.43½	.67	23½
December	.46½	.76	29½	.....	1.15	.....	.44	.59	15	.42½	.60	17½

Month.	1914			1915			1916		
			Cents.			*Cents.*			*Cents*
January	$0.41½	$0.59	17½	$0.65	$0.70½	5½	$0.63	$0.71	8
February	.41½	.67	25½	.84	.86	2	.65	.77	12
March	.45½	.62	16½	.75	.82	7	.60	.67	7
April	.44½	.59	14½	.75½	.76	½	.62	.73	11
May	.46½	.62	15½	.70	.78½	8½	.67	.77	10
June	.49½	.59	9½	.71½	.76	4½	.65	.73	8
July	.52½	.53½	1	.69½	.72½	3½	.71	.78	7
August	.50½	.56½	6	.65	.75	10	.72	.75	3
September	.66½	.76	9½	.47½	.60	12½	.86½	.98	11½
October	.65	.65	.....	.54	.56	2	.92	1.07	15
November	.69	.67	−2	.65½	.59	−6½	1.11¾	1.14	2½
December	.63	.68	5	.68	.67½	½	1.08	1.18	10

[1] Price quotations for Western No. 3 barley on the first market day of each month as given in the annual reports of the Canadian Department of Labor on "Wholesale prices."

[2] Lowest price quotations on Low Grade No. 3 barley on the first market day of each month as given in the Milwaukee Daily Commercial Letter.

FLAXSEED AND LINSEED OIL.

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FLAXSEED AND LINSEED OIL.

SUMMARY AND CONCLUSIONS.

Flaxseed has been essentially a pioneer crop, thriving on the frontier and moving with it. Because of the competition of newer regions, the greater comparative advantage of wheat and other crops, and also because of the unpopularity of the crop among farmers on account of flax wilt and other factors, the production of flaxseed in the United States since 1908 has been declining. The Dakotas, Minnesota, and Montana now produce nearly all of the domestic crop.

Until 1909 (barring occasional years when there was a shortage in production) a great deal of flaxseed was exported from the United States. After 1908, however, the decline in domestic production and the growing demand for linseed products caused the United States to become essentially a flaxseed-importing country. By 1914 it had become dependent upon foreign sources for about half its requirements. Within recent years Canada's surplus has not been sufficient to meet the American shortage, and most of the imports now come from Argentina, which has become the world's chief source of supply.

Practically all of the domestic crop, except the small portion retained for seeding purposes, finds its way to the American linseed oil mills. It is estimated that the annual requirements of these mills is from 28,000,000 to 30,000,000 bushels,[1] while the domestic production is around 10,000,000 bushels. Moreover, because of the shortage and high price of flaxseed, the use of domestic and imported substitute oils and adulterants has been greatly increasing. In the fiscal year 1920 imports of flaxseed amounted to $76,844,667.

Only three countries—Argentina, British India, and Canada—produce a large surplus of flaxseed, and their surplus fluctuates greatly from year to year. Formerly Russia was also a large exporter. The principal countries, other than Canada, from which it has been imported are Argentina and British India. Until 1912 most of the flaxseed imported from these countries was crushed by eastern mills. Thereafter a great deal was regularly imported from Canada and Argentina into the western lake region also, in response to the demands of the western linseed oil mills.

The Canadian import duty of 10 cents a bushel and the American duties of 25 cents (act of 1897) and 20 cents (act of 1913) have had

[1] Yearbook 1917, U. S. Department of Agriculture, p. 528.

little effect upon the movement of flaxseed across the boundary line. Imports into Canada have been insignificant, while the United States has imported a constantly increasing proportion of its supply, despite the import duties. During the period 1914–1920, about 80 per cent of Canada's entire crop moved to the United States, the annual value of the Canadian imports ranging between $4,750,000 and $17,334,000.

Prior to about 1905 Canada's production was insignificant. In the period 1905–1912 there was a rapid increase in the Canadian acreage, production, and exports. This increase was followed by a material decline during 1913-1917. Again in 1918, 1919, and 1920 Canada's acreage was greatly increased. Approximately 85 per cent of her crop is produced in the Province of Saskatchewan.

On account of the higher yield per acre in Canada, the cost of production is probably lower in that country than in the United States. Moreover, her flaxseed is generally of a better quality, and a much larger proportion of the crop is of the higher grades.

Since 1909 Canada has been essentially a flaxseed exporting country, and her import duty of 10 cents has had no appreciable effect upon the Winnipeg price.

From 1906 to 1908, inclusive, the flaxseed of the United States was on an export basis, and the Minneapolis price was not greatly affected by the American import duty of 25 cents. But in the period 1909 to 1916, inclusive, the Minneapolis price regularly exceeded the Winnipeg price; and in every year the excess was sufficient to cause large importations notwithstanding import duties.

It is obvious that, owing to the decline in American production and the growing demand for linseed products, the flaxseed producers of the Northwest were greatly benefited by the import duties during the years 1909 to 1916, and that they received a greater benefit from the duty of 25 cents, while in force, than they would have received from a duty of 20 cents.

It is impossible to estimate the precise amount of benefit that the producers of flaxseed have derived from import duties. Under complete freedom of trade there would be scarcely any difference between the Winnipeg and Minneapolis prices of comparable grades of flaxseed, because the freight rates from the flaxseed-producing areas of Saskatchewan to Fort William and Minneapolis were the same. In the period 1909 to 1916 the Minneapolis price would have been lower and the Winnipeg price higher. But from 1915 on, American market prices were based largely not on Canadian, but upon Argentine flaxseed, of which there were imported 3.9 million bushels in 1915, 11.4 millions in 1916, 5 millions in 1917, 7.2 millions in 1918, 6.9 millions in 1919, and 22.2 million bushels in 1920. The Argentine product has been finding its way to western oil mills besides

supplying the bulk of the eastern requirements. To an increasing extent, therefore, the price of Canadian and American seed at Minneapolis tends to equal the price of Argentine seed laid down at the same point. If the Argentine product moves to the United States, over the tariff barrier, rather than to the free markets of Great Britain (ocean freights usually being approximately the same to both countries), obviously it is because prices in the United States are correspondingly higher. It is also apparent that American consumers of linseed products paid this higher price for their entire supply, domestic as well as foreign. The excess was paid in part to domestic producers and in part to the Federal Treasury in the form of import duties upon the imported flaxseed. A customs revenue of from 1 to 5½ million dollars was annually derived from this source during the years 1911–1920.

Finally, it should be noted that the import duty of 25 and 20 cents per bushel constituted only a small proportion of the market price, and the fluctuations from season to season, often from month to month, are greatly in excess of this amount. The duties have had no appreciable influence in halting the decline in flaxseed production. And because of the unpopularity of the crop among farmers it is doubtful whether even a considerably higher rate of duty would effect an increase in production. Flaxseed culture has been tried in turn and abandoned in nearly all of the older agricultural regions of the United States.

For the western flaxseed crushing industry, as well as allied industries in the West, this progressive decline in the national production has created a serious problem. These industries were originally located in the interior, near the principal sources of the domestic raw material. Not only is the price of their flaxseed now increased by freight charges from the seaboard, but they are also at a similar disadvantage in shipping linseed oil and oil cake to the principal domestic and foreign markets.

THE FLAX PLANT—ITS USES AND CHARACTERISTICS.

Uses.—The flax plant is the source of two distinctly different products—a fiber derived from the straw and a seed containing an oil of superior drying qualities.[2] This flaxseed or linseed oil is used chiefly in the manufacture of paints, varnishes, and printer's ink, and also in many other products, such as oiled fabrics, oilcloth, linoleum, imitation and patent leather, waterproof clothing, oilskins, and soap. It is worthy of note, in connection with the tariff problem, that for one or other of its various uses a number of substitute oils and adulterants are available, and such substitutes are extensively employed when linseed prices become too high. The extraction of the oil leaves a by-product, linseed oil cake or meal, which is used as a stock feed.

Grown either for fiber or seed.—One of the peculiarities of the flax plant is that the same crop can not be commercially grown for both fiber and seed. Different varieties are used for these purposes. When grown for fiber, from 80 to 90 pounds of seed are sown to the acre, the long slender plants are pulled by hand before the seed is fully ripe, and in consequence the quality of the seed is impaired while its quantity is diminished.

On the other hand, the cultivation of flax for seed requires a seeding of only 15 to 20 pounds to the acre. The varieties grown for seed produce shorter and more branching plants, with many seeds; and the numerous branches tend to make the fiber in the main stalk coarse and uneven. This gives a larger yield in seed but a coarser straw; and the subsequent cutting and thrashing of the crop by machinery tends to destroy the value of the straw for textile uses. It follows, therefore, that flax is almost universally grown either for the fiber primarily, or exclusively for the seed.[3] In European countries, and in Japan, it is cultivated chiefly for the fiber; in the United States, Canada, Argentina, and British India it is cultivated almost entirely for seed. Russia is the only country which produces large quantities of both seed and fiber. Although the climate of parts of the United States and Canada is well adapted to fiber-flax culture, the large amount of hand labor involved in its production has prevented the development of the industry in these countries. Flaxseed,

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[2] "The usefulness of linseed oil in the industries is based upon the property of the oil to dry to a tough elastic film when exposed in thin layers to the action of the air. This film is resistant to the effects of heat and moisture in the outside elements to a remarkable degree."—U. S. Dept. of Agr. Bul. 655.

[3] Small quantities of seed are obtained as a by-product of fiber culture, while straw, the by-product of flaxseed culture, is used to some extent in the United States in the manufacture of rugs, insulation boards, upholstery, tow, and oakum.

however, is grown under the extensive methods characteristic of small grain cultivation.

Flaxseed primarily a frontier crop.—Flaxseed is a favorite "sod crop" in the west North-Central States, and the bulk of the domestic crop is grown on this newly broken sod. A good wheat crop can not be grown on such land until the second year. Some corn may be grown the first season, but the yield is much smaller than when this crop is grown on older land. Corn also is not a profitable crop in much of the present flax area. The ready adaptability of virgin sod land to flaxseed culture, the high price and marketable character of the product, the fact that the first harvest will pay at least for the cost of breaking and that it is better adapted than perhaps any other crop to rotting prairie sod in preparation for succeeding grain crops—these factors have made it especially alluring to the pioneer farmer in those sections where the climate has been favorable to grain production. The short season required for the maturity of flaxseed enables him to seed it on late breaking. With it he can break more land each year and still put it into crops than in the case of any other grain. Sooner or later, however, continuous cropping has always resulted in losses from flax wilt, which made further flax production unprofitable and caused the substitution of other crops.[4] Moreover, by reason of its late growth and lack of shade the plant is not a "weed fighter." Thus flaxseed has been a migratory crop, thriving on the frontier and moving with it. To some extent also it is grown in the spring wheat section as a catch crop on land prepared too late for wheat.

A cash crop.—Finally, it must be noted that flaxseed in its natural state has no domestic uses on the farms where it is produced except where the straw is fed to live stock or some seed retained for seeding purposes. The destination of practically all of the commercial crop is the linseed-oil mill.

TARIFF PROVISIONS WITH RESPECT TO FLAXSEED, LINSEED OIL, AND OIL CAKE.

The import duty upon the raw material, flaxseed, was maintained at 25 cents per bushel in the tariff acts of 1897 and 1909; in 1913 it was reduced to 20 cents per bushel, the rate formerly in force under

[4] The discontinuance of flaxseed culture in the older regions is not due to the fact that it exhausts the soil more than other grain crops, but is chiefly attributed to "flax-sick" soil; i. e., the soil becomes infested with parasitic diseases which render further production unprofitable. This flax-wilt is transmitted also through infected seed. According to recent investigations (1914–1917) flaxseed may profitably be grown in the older sections if the seed be disinfected and the crop grown in rotation. (U. S. Dept. of Agr., Farmers' Bul. 785.) In the past, however, seed flax culture has not found a permanent place chiefly because of the flax wilt and also because of the competition of the newer lands. Moreover, the crop is unpopular because "it makes weedy land," and also because of the difficulty of thrashing.

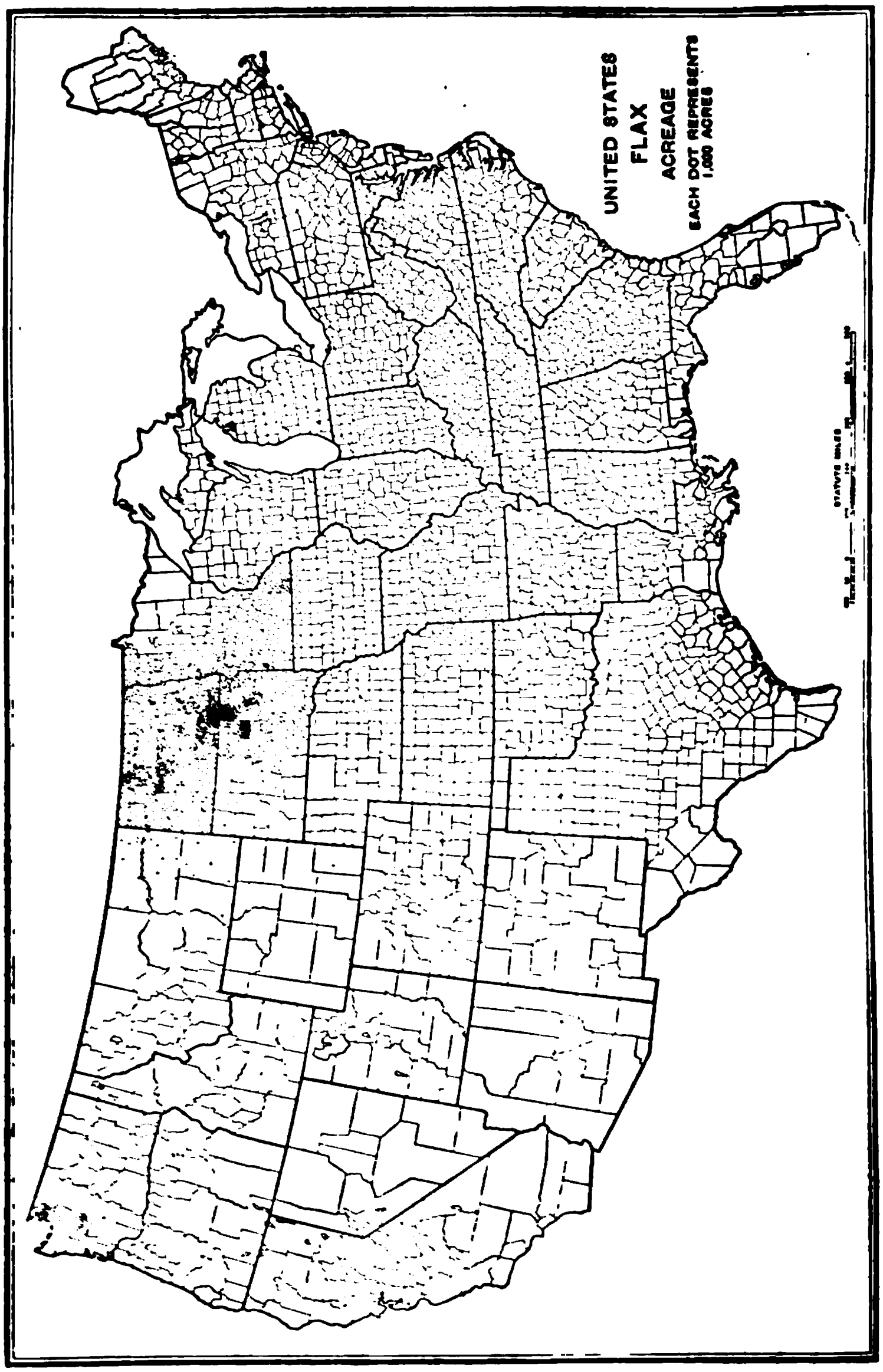
the acts of 1883 and 1890. Upon linseed oil, the present rate of duty under the 1913 act is 10 cents per gallon as compared to 15 and 20 cents in the two preceding tariff acts. As 1 bushel of flaxseed, dutiable at 20 cents per bushel, will yield about 2½ gallons of oil, the 10-cent rate upon linseed oil is more than a compensatory duty. The by-product, linseed oil cake, has been free of duty since 1883. Under the general rates of the Canadian customs tariff of 1907 flaxseed is dutiable at 10 cents per bushel, linseed oil at $1.65 per 100 pounds (12.4 cents per gallon), and oil cake is free of duty.

Import duties of the United States upon flaxseed, linseed oil, and linseed oil cake, 1883–1913.

Tariff act.		Tariff classification or description.	Rate of duty.
Year.	Paragraph.		
1883	466	Linseed or flaxseed	20 cents per bushel of 56 pounds.
		But no drawback should be allowed on oil cake made from imported seed.	
		Oil, flaxseed or linseed	25 cents per gallon.
		7½ pounds weight to be estimated as a gallon.	
		Oil cake	Free.
1890	285	Flaxseed or linseed	30 cents per bushel of 56 pounds.
		But no drawback should be allowed on oil cake made from imported seed.	
	41	Flaxseed or linseed oil, raw, boiled, or oxidized	32 cents per gallon of 7½ pounds weight.
	660	Oil cake	Free.
1894	206	Flaxseed or linseed	20 cents per bushel of 56 pounds.
	29	Flaxseed or linseed oil, raw, boiled, or oxidized	32 cents per gallon of 7½ pounds weight.
	567	Oil cake	Free.
1897	254	Flaxseed or linseed	25 cents per bushel of 56 pounds.
		But no drawback shall be allowed upon oil cake made from imported seed, nor shall any allowance be made for dirt or other impurities in any seed.	
	37	Flaxseed, linseed, oil, raw, boiled, or oxidized	20 cents per gallon of 7½ pounds.
	625	Oil cake	Free.
1909	266	Flaxseed or linseed	25 cents per bushel of 56 pounds.
	35	Flaxseed, linseed, oil, raw, boiled, or oxidized	15 cents per gallon of 7½ pounds weight.
	638	Oil cake	Free.
1913	212	Flaxseed or linseed	20 cents per bushel of 56 pounds.
	45	Oils, expressed: Flaxseed and linseed, raw, boiled, or oxidized.	10 cents per gallon of 7½ pounds.
	560	Oil cake	Free.

FLAXSEED PRODUCTION IN THE UNITED STATES.

A declining production.—In 1861 the production of flaxseed in the United States amounted to 1,730,000 bushels; in 1889, 10,250,000 bushels; in 1909, 25,856,000 bushels; and in 1919, 8,919,000 bushels on 1,683,000 acres. The farm value of the 1919 crop was over $39,000,000. The largest crops were harvested in the decade 1899 to 1909, when the average annual production was approximately 25,000,000 bushels and the area about 2,500,000 acres. Since that time, and especially since the beginning of the European war, both the acreage and production of flaxseed have materially declined. The acreage, production, and yield per acre since 1902 are shown in Table 1, and the geographic distribution of the acreage in the census year 1909 on Map 1.



MAP 1.—FLAXSEED ACREAGE IN THE UNITED STATES, 1909.
(From Yearbook, 1915, U. S. Department of Agriculture.)

TABLE 1.—*Acreage, production, and yield per acre of flaxseed in the United States, 1902–1920, and in Canada, 1908–1920.*

[Figures for the United States were compiled from Yearbooks and Monthly Crop Reporter of the Department of Agriculture. Figures for Canada are from the Canada Yearbooks and Census and Statistics Monthly.]

Year.	Acreage.		Production.		Yield per acre.	
	United States.	Canada.	United States.	Canada.	United States.	Canada.
	Acres.	*Acres.*	*Bushels.*	*Bushels.*	*Bushels.*	*Bushels.*
1902	100	.....	100	.....	7.8	.....
1903	100	.....	100	.....	8.4	.....
1904	100	.....	100	.....	10.3	.....
1905	100	.....	100	.....	11.2	.....
1906	100	.....	100	.....	10.2	.....
1907	100	.....	100	.....	9.0	.....
1908	100	100	100	00	9.6	10.76
1909	100	171	100	00	9.4	15.98
1910	100	126	100	68	[illegible]	7.29
1911	100	172	100	00	7.0	11.40
1912	100	2,100	100	00	9.8	12.92
1913	100	1,100	100	00	7.8	11.30
1914	100	1,100	100	00	8.4	6.62
1915	100	159	100	00	10.1	13.19
1916	100	181	100	00	9.7	12.56
1917	100	100	100	00	4.6	6.45
1918	100	1,100	100	00	7.0	5.75
1919	100	1,15	100	00	5.3	6.26
1920 [1]	100	1,64	100	00	.....	.....

[1] Preliminary figures.

Westward movement of flaxseed culture.—Formerly the chief flaxseed-producing area was in New York and Pennsylvania. By 1850 the center of production had moved westward to Ohio. From there the crop advanced into Indiana, Illinois, Wisconsin, Iowa, Missouri, and Kansas. In 1880 these were the principal flaxseed-producing States. During the next decade the crop advanced into Minnesota, Nebraska, and the Dakotas, while in Wisconsin and the Ohio Valley States production greatly declined. Since 1900 the great bulk of the crop has been produced in the northwestern States—Minnesota, the Dakotas, and Montana. In 1919 these four States contained 97 per cent of the area in flaxseed, and the crop of North Dakota alone now comprises about one-half of the country's total production. The westward movement of the crop since 1850 is shown in Table 2. It is evident that the future of seed-flax culture in the United States now rests not upon new lands but upon its establishment in crop rotations.

TABLE 2.—*Flaxseed production in the United States, by States, 1849–1919.*

[From "Flax: The Fiber and Seed," by Walter S. Barker; Quarterly Journal of Economics, May, 1917.]

[In thousands of bushels.]

State.	1849	1859	1869	1879	1889	1899	1909	1919
Pennsylvania	42	24	16	5	4	.....	.....	.....
New York	58	57	93	72	21	1	.....	.....
Ohio	189	242	632	593	146	30	5	.....
Indiana	37	119	402	1,419	18	1	.....	.....
Illinois	11	9	280	1,812	35	4	1	.....
Wisconsin	1	4	112	547	68	141	119	63
Iowa	2	6	89	1,511	2,282	1,413	141	152
Nebraska	.....	.....	.....	78	1,401	55	21	13
Minnesota	.....	.....	19	99	2,722	5,895	3,277	2,880
Missouri	14	5	10	379	451	612	155	45
Kansas	.....	.....	2	513	994	1,418	302	85
Oklahoma	.....	.....	.....	.....	.....	20	9	.....
Colorado	.....	.....	.....	.....	2	2	13	.....
South Dakota	.....	.....	.....	27	1,801	2,452	4,760	1,160
North Dakota	.....	.....	.....	.....	164	7,767	10,246	3,800
Montana	.....	.....	.....	.....	.....	1	447	65
Wyoming	.....	.....	.....	.....	.....	.....	6	16

NOTE.—The vertical lines of the steps indicate maximum production; connected, they show the westward movement of the flaxseed belt and the close intimacy between pioneer farming and flax culture. About 90 per cent of the production, prior to 1909, was below the line.

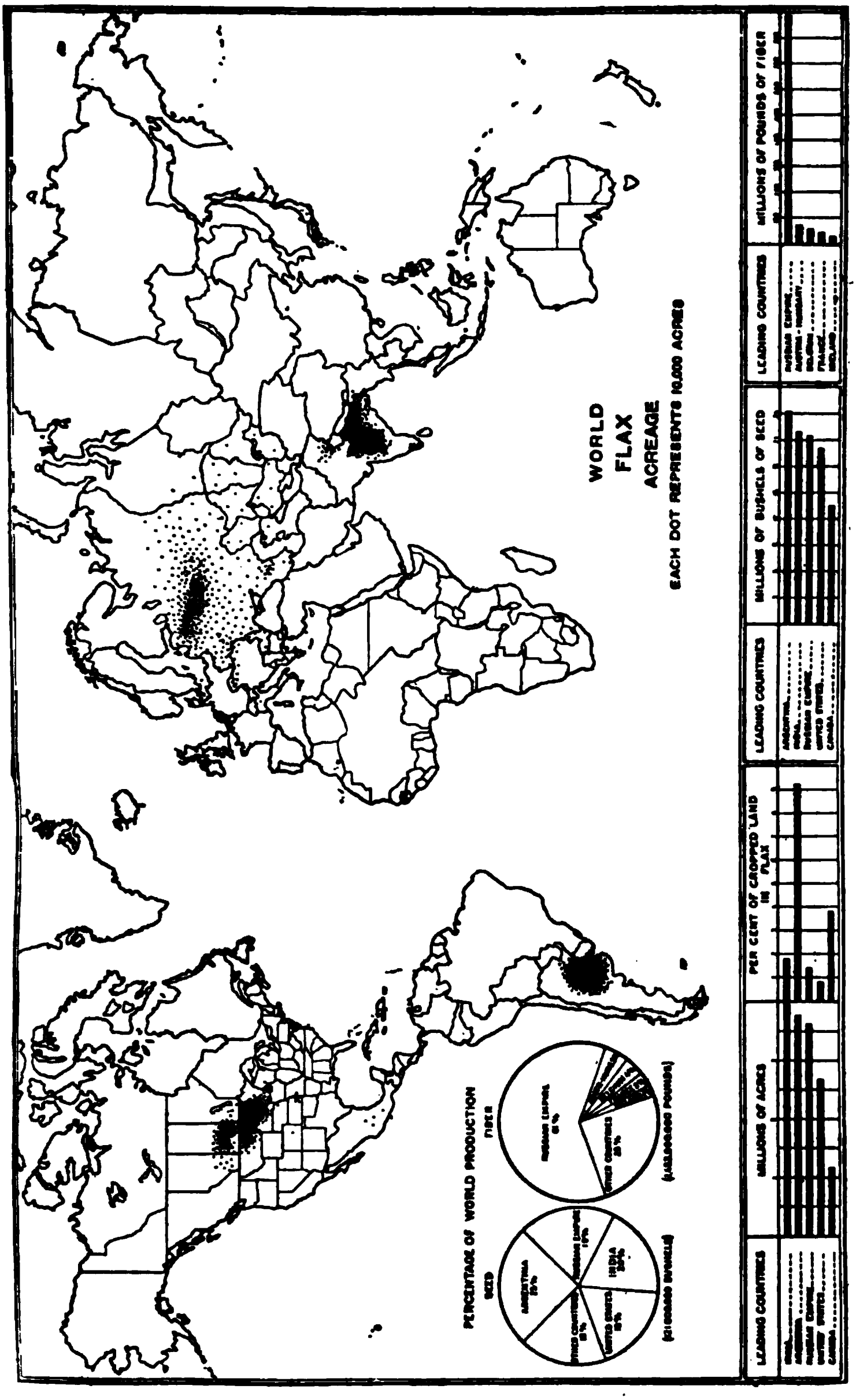
Northwestern and southwestern flaxseed.—The flaxseed produced in Iowa, Wisconsin, Minnesota, the Dakotas, and Montana is designated commercially as the "northwestern crop," as distinguished from the "southwestern crop," the latter being the grain produced in Nebraska, Kansas, Missouri, and Oklahoma. The distinction grows out of the difference in the oil content of the seed. Largely because of climatic conditions, the seed of the Northwest is larger and yields from 18 to 20 pounds of oil to the bushel, while the small-grained seed of the Southwest yields an average of only 16 to 17 pounds of oil to the bushel.[5] Occasional attempts to improve the quality of the flaxseed crop of the Southwest by the introduction of foreign seed have resulted only in the rapid reversion of the new variety to the American type. Partly for this reason there has been a greater decline of flaxseed production in the southwestern than in the northwestern States;[6] by 1919 the acreage of the latter had dwindled to less than 3 per cent of the total.

WORLD PRODUCTION.

Producing regions.—The United States and four other countries—Argentina, Russia, British India, and Canada—produce about 95 per cent of the world's flaxseed supply. With the exception of Canada, all of these countries now produce a larger quantity than

[5] There is virtually no waste in the crushing mill, the balance of the flaxseed (containing also a small percentage of oil) being sold as cake.

[6] For a fuller discussion of flaxseed production, consumption, and commerce, see article by C. M. Daugherty in U. S. Dept. of Agr. Yearbook, 1902; also "Seed Flax Production," by Chas. H. Clark, Farmers' Bul. 785, U. S. Dept. of Agr.; and "Flax, the Fiber and Seed. A study in Agricultural Contrasts," by Walter S. Barker, in Quarterly Journal of Economics, May, 1917.



MAP 2.—WORLD ACREAGE IN FLAXSEED. (From Yearbook, 1916, U. S. Dept. of Agr.)

does the United States, and they have been the chief producers and exporters for several decades. Of the world crop of approximately 110,000,000 bushels (average for 1909–1913), Argentina produced 32,000,000 bushels, or nearly 30 per cent; Russia, 21,200,000 bushels, or 19 per cent; British India, 19,733,000 bushels, or 18 per cent; the United States, 19,500,000 bushels, or 17.7 per cent; and Canada, 12,068,000 bushels, or 11 per cent. Within recent years the shortage and high prices of flaxseed have resulted in an extensive use of adulterants and substitutes for linseed oil, such as soya bean, perilla, tung, corn, and fish oils.

Production in Canada.—In Canada flaxseed is a comparatively recent crop. While it has long been grown to a small extent in Ontario and Quebec, in rotation with other crops, it is only since 1910 and the opening of new lands in Manitoba, Saskatchewan, and Alberta that it has come to be an important agricultural product. The crop of 1912, amounting to 26,130,000 bushels, was by far the largest ever produced in the Dominion. Of the entire crop, 99 per cent was produced in the prairie Provinces, and 88 per cent in Saskatchewan alone. That Province has continued to be the chief producer of flaxseed, but from 1912 on, and especially during the war period, the acreage and production have greatly declined. With the return to normal conditions and the opening up of new lands, a great increase in production seems probable. The area sown to flaxseed in each of the years 1918 and 1919 was over 1,000,000 acres, twice that of 1917, but on account of unfavorable climatic conditions only a small crop was harvested. The acreage, production, and yield per acre for Canada as a whole since 1908 are shown in Table 1; and by Provinces, since 1900, in Table 3.[7]

TABLE 3.—*Flaxseed acreage and production in Canada, by Provinces, 1900–1919.*

[From Canada Yearbooks and Census and Statistics Monthly.]

ACREAGE.

Province.	1919	1915	1912	1910	1900
Canada	1,093,115	463,359	2,021,900	582,326	23,0[illegible]
Prince Edward Island	.....	.....	.....	.....	[illegible]
Nova Scotia	.....	.....	.....	.....	.....
New Brunswick	.....	.....	.....	.....	5[illegible]
Quebec	11,384	600	900	1,361	1,[illegible]1
Ontario	13,717	5,000	9,000	8,780	6,3[illegible]
Manitoba	57,379	14,505	100,000	34,684	14,4[illegible]4
Saskatchewan	929,945	395,254	1,780,000	506,425	22[illegible]
Alberta	80,690	48,000	132,000	31,076	100
British Columbia	.....	.....	.....	.....	1

[7] The report of the Saskatchewan Department of Agriculture for the year 1917 gives the results of an inquiry as to the cause of the diminishing acreage in flaxseed. The returns stated that the crop was still being produced in the newer districts; and the reasons most generally given for its unpopularity elsewhere were: The greater comparative advantage of other crops, especially of wheat; the fact that flax makes weedy land and is subject to injury by early frost; the difficulty in getting it thrashed; uncertain yield and price.

TABLE 3.—*Flaxseed acreage and production in Canada, by Provinces, 1900–1919*—Continued.

PRODUCTION (BUSHELS).

Province.	1919	1915	1912	1910	1900
Canada	6,767,000	6,114,000	26,130,000	4,244,566	172,222
Prince Edward Island	.....	.....	.....	.....	281
Nova Scotia	.....	.....	.....	.....	58
New Brunswick	.....	.....	.....	.....	283
Quebec	128,000	7,000	9,000	13,350	19,309
Ontario	206,000	62,000	143,000	82,901	67,276
Manitoba	631,000	120,000	1,252,000	176,675	81,898
Saskatchewan	5,580,000	5,255,000	23,033,000	3,893,160	2,420
Alberta	222,000	670,000	1,693,000	78,480	693
British Columbia	.....	.....	.....	.....	4

Production in Argentina and other countries.—The flaxseed crop of Russia remained about stationary between 1900 and 1914, the average yearly production being about 20,000,000 bushels. In India production has been irregular, but the acreage has increased. The greatest increase in acreage and production has taken place in Argentina, whose crop fluctuates greatly from year to year. In 1900 her flaxseed crop amounted to 8,865,000 bushels; in 1915, 45,040,000 bushels were produced. Since 1902 the annual production of Argentina has ordinarily exceeded that of any other nation. But it is noteworthy that even in Argentina the acreage in flaxseed declined between the years 1914 and 1918. (Average 1909–1913, 3,683,000 acres; 1918, 3,229,000 acres.)

In Argentina, which has become the world's chief source of supply, the crop is grown under conditions almost the reverse of those obtaining in North American producing sections. In the latter, flaxseed is raised chiefly in the dry-farming regions, on new land. In the producing sections of Argentina, on the other hand, it is grown in rotation with corn on old, fertile land in the best agricultural sections; the climate is humid and semitropical, and the growing season from one to two months longer than in the North American flaxseed regions. Argentine yields are very uncertain, however; while the crop is usually comparatively free from flax wilt and other diseases, severe damage is often caused by a variable climate, resulting in losses by frost or excessive heat, drought or torrential rains and cloud-bursts, and by visitations of locusts. It is also noteworthy that the Argentine Government levies an export tax amounting to about 7 cents per bushel of flaxseed. In September, 1920, ocean freight rates from Buenos Aires to North Atlantic ports were about 35 cents per bushel.

COMPARATIVE PRODUCTIVITY AND COST.

In the period from 1908 to 1916, inclusive, the average yield of flaxseed per acre in Russia was 5.07 bushels; in British India, 5.08

bushels; in the United States, 8.42 bushels; in Argentina, 9.11 bushels; and in Canada, 11.07 bushels.

A comparison of the yields per acre in Canada and the United States (see Table 1) shows that the Canadian yield per acre was larger than the American yield in all years except 1914 and 1915. Owing to the importance of Saskatchewan in the production of flaxseed, the average yields per acre in that Province have corresponded closely with the average for the whole of Canada, which for the 10-year period 1910–1919 was 9.4 bushels as compared with 7.5 for the United States. In North Dakota, the chief flaxseed-producing State, the average yield per acre for the same period has been 7.3 bushels, slightly less than the average for the whole country. In the other States of large production the average yields were as follows: Minnesota, 9.2; South Dakota, 7.8; Montana, 7.1 bushels. The average yield in Manitoba was 10.8 bushels; and in Alberta, 9.1 bushels.

Unfortunately, there are no comparable data as to the cost of producing a bushel of flaxseed in the two countries. But in view of the larger yield per acre of flaxseed in Canada, together with lower land values and seed costs, there can be little question that the cost of production in that country is lower than in the United States. Moreover, the Canadian product is of superior quality, and a much larger proportion of the crop is of the better grades (see p. 144). So marked a difference in the Canadian and American yields can not be ascribed to differences in the intensiveness of culture, for in both countries the chief centers of flaxseed production are confined largely to the new farming areas where methods of cultivation are substantially the same.

The average yields per acre in Argentina, British India, Russia, and the United States can not, as in the case of Canada and the United States, be made the basis for cost comparisons. Prices, wages, and the methods of cultivation are so obviously different in the several countries as to render all comparisons, in the absence of authoritative cost data, misleading and valueless.

TRADE IN FLAXSEED, LINSEED OIL, AND LINSEED OIL CAKE.

Increasing deficiency of flaxseed in the United States.—It will be seen from an examination of Table 4 that a fundamental change has recently taken place in the relation between American exports and imports of flaxseed. Prior to 1909 the yearly production of the grain normally exceeded domestic requirements and there was a fairly large surplus available for export. From 1909 on, however, production declined and exports virtually ceased, while imports rose rapidly. By 1914 the United States had become dependent upon foreign sources for about one-half of its flaxseed requirements. Since that year imports have ranged between $20,000,000 and

$77,000,000, of which Canada has contributed from $5,000,000 to $17,000,000.

TABLE 4.—*Flaxseed trade of the United States and Canada, 1902–1920.*

[From Foreign Commerce and Navigation of the United States; Canada Yearbooks, and Canadian Trade and Commerce returns.]

Year.	United States.		Canada.	
	General imports.	Domestic exports.	Imports for home consumption.[1]	Domestic exports.
		Bushels.	*Bushels.*	*Bushels.*
1902	[illegible]57	3,874,033	[illegible]6	868
1903	[illegible]89	4,128,130	[illegible]2	.....
1904	[illegible]70	758,379	[illegible]4	1,411
1905	[illegible]84	1,338	[illegible]2	314
1906	[illegible]40	5,988,519	1, [illegible]3	2,824
1907	[illegible]56	6,636,310	2, [illegible]4	
1908	[illegible]19	4,277,313	1, [illegible]1	
1909	[illegible]68	882,899	[illegible]6	
1910	[illegible]96	65,193	[illegible]4	
1911	[illegible]27	976	[illegible]7	
1912	[illegible]06	4,323	[illegible]0	
1913	[illegible]96	16,894	[illegible]6	
1914	[illegible]35	305,546	[illegible]7	
1915	[illegible]15	4,145	[illegible]1	
1916	[illegible]33	2,614	[illegible]6	
1917	[illegible]88	1,017	1,005	
1918	[illegible]29	21,481	4,638	
1919	[illegible]86	15,574	17,660	
1920	[illegible]34	24,044	107,522	

[1] Nearly all of the Canadian imports were received from the United States.

Domestic linseed oil industry.—It has already been noted that practically all of the flaxseed crop, except the small portion required for seeding purposes, finds its way to the linseed-oil mill. There are three freights to be considered in establishing an oil mill—the freight on the flaxseed, upon the oil cake (the greater part of which is exported), and upon the linseed oil. In the West, the manufacture of linseed oil has become largely localized in cities on or near the Great Lakes, particularly Minneapolis and Chicago. The bulk of the seed received at Minneapolis and Chicago is shipped out in the form of manufactured products. Duluth is the great primary market, its function being entirely distributive. From that center the linseed-oil mills at Buffalo, New York City, and Philadelphia, in short the eastern branch of the industry, derive their supplies of the domestic grain. The apparent disadvantage of the eastern mills in being far removed from the base of their raw material is partly overcome by the fact that Buffalo enjoys both the advantage of all-lake transportation from the primary market, Duluth, and of the cheaper freights via the Erie Canal upon the oil and oil cake. New York City is the center of a large consuming market and enjoys exceptional advantages both for the exportation of the by-product, linseed oil cake, and for the importation of foreign seed.

The amount of seed crushed at the five great linseed-oil producing centers, Buffalo, New York City, Minneapolis, Toledo, and Chicago,

is not far from 70 per cent of the entire volume of flaxseed crushed in the United States. The total annual requirement of the American linseed-oil industry is between 28,000,000 and 30,000,000 bushels of which a little more than one-third is now produced in this country.

Source and distribution of imported flaxseed.—The decline in the production of flaxseed since 1908, together with the growing demand for paint, varnish, printer's ink, and other products in the manufacture of which linseed oil finds its principal use, has caused a tremendous increase in the imports of flaxseed. Likewise the imports of substitute oils, such as perilla, tung, and soya bean oils, have greatly increased. Since 1910 Canada's flaxseed surplus has not sufficed to meet the increasing deficiency of the United States, and large importations have been made from Argentina and British India. Within recent years the supplies drawn from Argentina have exceeded those from Canada, which now exports nearly all of her surplus to the United States. The principal port of entry for Canadian seed has been Buffalo; while the great bulk of the flaxseed imported from other countries has entered the United States at New York City. The eastern mills, far removed from the flaxseed-producing sections of the United States, have come to depend almost entirely upon Canada, Argentina, and British India for their raw material. And more recently even the western crushers began to use, first, Canadian and, later, Argentine seed. These western crushers, who originally located their plants in the regions of large domestic production, confront a serious problem in the declining national supply. In the higher prices for their raw material and in their greater distance from the principal domestic and foreign consuming markets. they are at an obvious disadvantage in competition with eastern linseed interests.

TABLE 5.—*Flaxseed trade: Origin of imports into the United States and destination of all exports from Canada, 1908–1919.*

[From Commerce and Navigation of the United States and Canada Yearbooks.]

Year.	Imports into the United States from—			Exports from Canada to—	
	Canada.	Argentina.	British India.	United States.	All other countries.
	Bushels.	*Bushels.*	*Bushels.*	*Bushels.*	*Bushels.*
1908	7,418	28	35,941	1	10,995
1909	479,189	76,000	3,995	12,395	681,384
1910	1,410,398	3,209,087	193,628	449,739	1,547,909
1911	2,251,083	5,021,137	2,333,863	1,677,062	1,019,057
1912	3,510,883	1,210,628	1,525,310	991,802	512,721
1913	4,732,316	429,254	128,981	7,561,004	2,562,680
1914	8,647,168	.....	50	10,164,536	10,482,791
1915	6,629,860	3,927,542	39,990	7,006,249	683,276
1916	3,094,735	11,468,039	.....	1,930,592	13,951
1917	7,014,573	5,009,441	122,596	4,979,534	216,403
1918	5,501,391	7,432,421	.....	6,371,285	53,265
1919[1]	1,304,337	6,976,518	.....	1,723,161	167,817
1920[1]	816,343	22,241,565	.....	1,020,192	72,755

[1] Preliminary figures.

Thus in the fiscal year ending June 30, 1910, imports from Argentina amounted to 3,209,087 bushels, and New York City was the port of entry for 3,028,384 bushels; the amount imported from Canada was 1,410,398 bushels, and Buffalo was the port of entry for 1,239,265 bushels. Again, in the fiscal year 1911, imports from Argentina and British India were 5,021,137 and 2,333,863 bushels, respectively; New York City being the port of entry for 6,955,661 bushels and Philadelphia for 1,065,486 bushels. Imports from Canada were but slightly larger than the amount entered at Buffalo—2,050,112 bushels. So great was the shortage in that year that there were also imported 3,959,476 gallons of linseed oil, in the face of the higher import duty upon the manufactured product.

Although more than one-half of the importations of 1912 consisted of Canadian seed, the imports from Argentina and British India were fairly large—1,210,628 and 1,525,310 bushels, respectively. But while New York was the port of entry for 3,740,070 bushels, or about 1,000,000 bushels more than the imports from these two countries, Buffalo received less than one-half of the Canadian shipments (1,584,655 out of 3,510,883 bushels). It is significant that from 1912 on the amounts entered at Buffalo (that is, the Canadian exports to the Eastern mills) were but slightly more than one-half of the total imports from Canada. The western lake ports and the western customs districts of the border began to take a large part of the importations from Canada. For the first time the western lake region came into prominence as an importing section. Previously the linseed-oil mills of the West, located near the source of their raw material, had experienced little difficulty in securing all of the domestic flaxseed that the scale of their operations required. In fact, there had usually been a large surplus for shipment to the eastern mills. But after 1911 the decline in the production of flaxseed in the Western States made it profitable for western mills to look to Canada for a part of their raw material, and the Canadian product regularly entered this country at Chicago, Duluth, the lake ports of Ohio, and across the northern border of Minnesota and North Dakota. There is also a movement to the Pacific States, which produce very little flaxseed and are far distant from American sources of supply.

TABLE 6.—*Imports of flaxseed into the United States, by principal customs districts, 1908–1920.*

[From United States Commerce and Navigation.]

Year.	New York.	Buffalo.	Philadelphia.	Ohio.	Duluth and Superior.
	Bushels.	*Bushels.*	*Bushels.*	*Bushels.*	*Bushels.*
1908	49,960	.....	.....	.....	6,2[illegible]
1909	110,482	261,468	.....	155,449	47,[illegible]
1910	3,028,384	1,239,265	624,097	.....	33,0[illegible]
1911	6,955,661	2,050,112	1,065,486	275,851	28,4[illegible]
1912	3,740,070	1,584,655	128,676	117,234	738,6[illegible]
1913	1,393,850	2,552,567	101,521	153,819	465,4[illegible]
1914	1,906,470	4,483,585	.....	605,239	749,0[illegible]
1915	4,639,147	3,875,413	342,544	321,929	1,120,5[illegible]
1916	10,400,622	1,840,680	360,091	251,042	685,4[illegible]
1917	5,339,107	4,595,551	.....	197,569	1,484,3[illegible]
1918	7,629,312	3,551,778	.....	354,600	886,4[illegible]
1919[1]	6,920,143	750,677	.....	32,784	476,9[illegible]
1920[1]	21,489,204	324,342	227,184	.....	281,3[illegible]

Year.	Chicago.	Minnesota.	North and South Dakota.	All other districts.	Total.
	Bushels.	*Bushels.*	*Bushels.*	*Bushels.*	*Bushels.*
1908	.....	9	1,130	42	57,4[illegible]
1909	2	10,097	4,019	4,607	593,9[illegible]
1910	5	49,268	6,786	21,682	5,002,4[illegible]
1911	13,691	7,672	15,178	87,164	10,499,2[illegible]
1912	90,000	321,415	64,557	36,541	6,841,9[illegible]
1913	120,540	474,633	29,334	2,547	5,294,2[illegible]
1914	623,112	207,518	.....	79,240	8,653,2[illegible]
1915	227,204	53,814	32,858	52,791	10,666,2[illegible]
1916	281,133	161,335	16,660	682,204	14,679,[illegible]
1917	9,984	196,870	111,802	458,766	12,333,[illegible]
1918	138,227	539,339	30,343	236,450	13,366,[illegible]
1919[1]	21,797	136,104	18,652	69,815	8,426,[illegible]
1920[1]	.....	219,506	19,741	830,153	23,391,9[illegible]

[1] Preliminary figures.

Drawbacks: Trade in linseed oil and cake.—The trade in flaxseed is complicated by the drawback provisions of the customs regulations, by other features of the foreign trade in the immediate products of flaxseed (linseed oil and cake), and likewise by the trade in the commodities in which the oil is employed (chiefly paints, varnishes, soaps, oilcloth).

A bushel of flaxseed (56 pounds) will yield about 2½ gallons of linseed oil (7½ pounds per gallon) and about 36 pounds of oil cake. Table 7 shows that the foreign trade in linseed oil is about 1 or 2 per cent of the American production or consumption, and that a large part of the relatively small exports of oil was manufactured from imported flaxseed, upon which the customs duty was refunded. But the by-product, oil cake, is normally on an export basis, Europe taking nearly three-fourths of the American production. A comparison of the oil cake exports with the figures of flaxseed production and imports shows that a relatively small part of the by-product is ordinarily retained within the United States. Consequently the drawback provision is of considerable importance.

TABLE 7. *Foreign trade of the United States in linseed oil and oil cake; flaxseed and articles containing flaxseed products exported with benefit of drawback, 1910–1920.*

[Compiled from Foreign Commerce and Navigation of the United States.]

Year.	1	2	3	4	5	6	7	8	9
	Foreign flaxseed contained in—		Linseed oil cake.		Linseed oil.		Drawbacks paid on [1]—		
	Exported linseed oil cake.	Exported linseed oil.	Total exports (including column 4).	Exports manufactured from foreign flaxseed.	Total exports (including column 6).	Exports manufactured from foreign flaxseed.	Linseed oil cake.	Linseed oil.	Linseed oil imports.[2]
	Bushels.	*Bushels.*	*Pounds.*	*Pounds.*	*Gallons.*	*Gallons.*	*Dollars.*	*Dollars.*	*Gallons.*
1910	37,126	.....	652,316,916	1,291,590	228,426	.....	2,255	.....	463,174
1911	5,181,668	.....	559,674,653	213,535,593	175,210	.....	314,141	.....	3,959,475
1912	8,181,539	1,030	596,114,536	363,719,403	246,965	2,776	528,668	181	737,256
1913	1,549,266	117,112	838,119,654	224,299,884	1,733,925	468,807	383,443	29,985	173,690
1914	656,640	118,050	662,868,639	87,527,449	239,188	435,216	163,222	29,220	192,282
1915	304,176	533,023	524,794,434	38,395,779	1,212,133	1,585,081	75,178	115,649	535,291
1916	19,685	25,681	640,916,196	2,567,191	714,120	80,699	4,872	5,761	50,148
1917	.....	5,543	536,984,394	.....	1,201,554	14,103	.....	1,145	110,808
1918	.....	135,711	151,399,977	.....	1,187,850	396,988	.....	26,911	50,827
1919	.....	([3])	202,788,273	.....	1,096,304	([3])	.....	([3])	989,812
1920	.....	([3])	336,335,912	.....	1,136,585	([3])	.....	([3])	4,550,391

[1] Drawbacks amounting to less than $10,000 annually were also paid on foreign flaxseed or oil used in exported paints and varnishes.
[2] Imports for consumption 1910 and 1911; general imports in other years.
[3] Data not available.

The United States being a flaxseed importing country, it is obvious that in the same markets like prices should prevail for foreign and domestic seed of equal quality. But if foreign flaxseed be used in producing export products (linseed oil and paints, for instance), the manufacturer may obtain a refund of 99 per cent of the customs duty upon the imported flaxseed (now 20 cents per bushel). For this reason flaxseed crushers can afford to pay more for Canadian seed, and this is doubtless one reason why Minneapolis prices seldom exceed Winnipeg quotations by the full amount of the import duty. Reference to the figures given above will show that in the years 1910 to 1916 a large part of the imported flaxseed was reexported in the form of oil cake. In the year 1912 over 8,000,000 bushels of foreign flaxseed were reexported in this form. But the tariff act of October 3, 1913, provides that where a by-product is on the free list, and it alone is exported, no drawback should be allowed. All oil cake being on the free list, such drawbacks have greatly declined since 1913.[3] Oil exports have usually been small, and the drawback sta-

[3] Tariff act of October 3, 1913, Section IV, paragraph O: That upon the exportation of articles manufactured or produced in the United States by the use of imported merchandise or materials upon which customs duties have been paid, the full amount of such duties paid upon the quantity of materials used in the manufacture or production of the exported product shall be refunded as drawback, less 1 per centum of such duties: *Provided*, That where a principal product and a by-product result from the manipulation

tistics show that only small quantities of imported flaxseed or oil were used in exported paints, varnishes, linoleum, and soaps.

COMPARATIVE PRICES.

Grades and markets.—The contract grade for flaxseed in Winnipeg is "No. 1 Northwestern," which must be "mature, sound, dry, and sweet, and contain no more than 12½ per cent of damaged seed, and weigh not less than 53 pounds to the bushel of commercially pure seed."[9] During the years 1910–1916 this grade constituted from 75 to 95 per cent of the annual receipts at Fort William. In Minneapolis, No. 1 Northwestern seldom amounted to as much as 1 per cent of the receipts; the contract grade is No. 1, a lower grade, which was from 82 to 96 per cent of the receipts during 1909–1916. As prescribed by the Minnesota Grain Appeals and Inspection Board, No. 1 "shall be northern grown, sound, dry, and free from mustiness, and carry not more than 20 per cent of immature or field stack, storage, or other damaged seed, and weigh not less than 49 pounds to the measured bushel of commercially pure seed."

Thus the contract grade in Winnipeg is apparently worth more per bushel than is the Minneapolis grade.[10] In both countries, however, sales are by weight, the legal weight for a bushel of flaxseed being 56 pounds. This weight of the Canadian product would yield a smaller volume, but plumper seed with a higher oil content than the American product, which, on the other hand, would yield a larger amount of cake. But according to the rules of the Minneapolis Chamber of Commerce, No. 1 Canadian is deliverable for No. 1, and no premium is stated. These differences, and the effect of the drawback regulations, should be borne in mind in connection with the price comparisons which follow.

Price comparisons, Minneapolis and Winnipeg.—In Table 8, page 145, will be found the quotations of No. 1 Northwestern flaxseed

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of imported material and only the by-product is exported, the proportion of the drawback distributed to such by-product shall not exceed the duty assessable under this act on a similar by-product of foreign origin if imported into the United States. Where no duty is assessable upon the importation of a corresponding by-product, no drawback shall be payable on such by-product produced from the imported material; if, however, the principal product is exported, then on the exportation thereof there shall be refunded as drawback the whole of the duty paid on the imported material used in the production of both the principal and the by-product, less 1 per cent, as hereinbefore provided.

[9] Report of the Canadian Department of Labour on "Comparative prices, Canada and the United States," 1911, p. 13.

[10] The official measure used in establishing the Canadian grade, the Imperial bushel, is 1.0315 as large as the Winchester bushel, the American measure.

in Winnipeg[11] and No. 1 Northern in Minneapolis, for the first market day of each month during the years 1906 to 1916 inclusive.

TABLE 8.—*Cash flaxseed prices per bushel in Winnipeg and Minneapolis on the opening market day of each month, and the advance of the Minneapolis over the Winnipeg price, 1906–1916.*

(Before and after the reduction in the American import duty from 25 cents to 20 cents per bushel, Tariff Act of October 3, 1913.)

Month.	1906			1907			1908		
	Winnipeg.[1]	Minneapolis.[2]	Excess of Minneapolis over Winnipeg price.	Winnipeg.	Minneapolis.	Excess of Minneapolis over Winnipeg price.	Winnipeg.	Minneapolis.	Excess of Minneapolis over Winnipeg price.
			Cents.			*Cents.*			*Cents.*
January	$0.96½	$1.15½	19½	$1.16½	$1.17½	1	$1.04	$1.19½	15½
February	1.16	1.16	.....	1.19	1.22½	3½	1.08	1.16½	8½
March	1.06	1.10½	4½	1.19½	1.20½	1	1.03½	1.16½	12½
April	1.10	1.14½	4½	1.25½	1.16	[3] 9½	1.07½	1.15	7½
May	1.11	1.13½	2½	1.26	1.17½	[3] 8½	1.14½	1.20½	5½
June	1.09	1.11	2	1.33	1.28½	[3] 4½	1.19	1.24½	5½
July	1.07	1.11½	4½	1.33	1.21	[3] 12	1.14	1.20½	6½
August	1.04	1.08½	4½	1.28	1.13½	[3] 14½	1.20	1.24	4
September	1.03	1.09½	6½	1.20	1.18½	[3] 1½	1.24	1.26	2
October	1.08	1.10½	2½	1.27	1.25½	[3] 1½	1.18	1.20½	2½
November	1.13½	1.12½	[3] 1½	1.25½	1.17½	[3] 7½	1.19	1.26½	7½
December	1.20	1.17½	[3] 2½	1.04½	1.08½	4	1.19	1.43½	24½

Month.	1909			1910			1911		
	Winnipeg.	Minneapolis.	Excess of Minneapolis over Winnipeg price.	Winnipeg.	Minneapolis.	Excess of Minneapolis over Winnipeg price.	Winnipeg.	Minneapolis.	Excess of Minneapolis over Winnipeg price.
			Cents.			*Cents.*			*Cents.*
January	$1.20½	$1.53½	33½	$1.81	$2.10½	29½	$2.22	$2.48½	26½
February	1.25	1.58½	33½	1.89½	2.16½	27½	2.40	2.64½	24½
March	1.36	1.67½	31½	1.90	2.17½	27½	2.44	2.64½	20½
April	1.35	1.65½	30½	2.10	2.34½	24½	2.35	2.49	14
May	1.37	1.63½	26½	2.06	2.37	31	2.32	2.55	23
June	1.48½	1.74½	26	1.60	2.08	48	2.18	2.21	3
July	1.52	1.74½	22½	1.85	2.10	25	1.70	2.05	35
August	.....	1.37½	.....	2.20	2.41	21	2.05	2.16	11
September	1.27	1.39½	12½	2.25	2.50	25	2.40	2.52	12
October	1.32½	1.36½	4	2.18	2.41½	23½	2.20	2.32½	12½
November	1.55	1.70½	15½	2.48	2.60½	17½	1.95	2.17½	22½
December	1.52	1.79½	27½	2.30	2.53½	23½	.....	1.95½	.....

[1] Quotations for No. 1 Northwestern as given in the annual reports of the Canadian Department of Labor on "Wholesale Prices."

[2] Quotations for No. 1 Northwestern as given in the annual reports of the Minneapolis Chamber of Commerce.

[3] Excess of Winnipeg over Minneapolis price.

[11] As in the case of the other grains, the Winnipeg quotations are for flaxseed in store at Fort William or Port Arthur.

TABLE 8.—*Cash flaxseed prices per bushel in Winnipeg and Minneapolis on the opening market day of each month, and the advance of the Minneapolis over the Winnipeg price, 1906–1916*—Continued.

Month.	1912			1913			1914		
	Winnipeg.	Minneapolis.	Excess of Minneapolis over Winnipeg price.	Winnipeg.	Minneapolis.	Excess of Minneapolis over Winnipeg price.	Winnipeg.	Minneapolis.	Excess of Minneapolis over Winnipeg price.
			Cents.			*Cents.*			*Cents.*
January	$1.89	$2.12½	23½	$1.03⅜	$1.25⅜	22	$1.27½	$1.45½	
February	1.92	2.08	16	1.13½	1.34½	21	1.27	1.47	
March	1.83	2.02	19	1.09⅜	1.29	19⅝	1.33⅜	1.57⅜	
April	1.90½	2.16	25½	1.07⅜	1.23⅜	16	1.37½	1.55	
May	1.97	2.14½	17½	1.15⅜	1.32⅜	16⅞	1.36	1.52⅜	
June	1.97½	2.24	26½	1.14⅜	1.28⅜	14⅛	1.39⅞	1.56⅜	
July	2.02	2.17	15	1.17⅜	1.33	15⅝	1.39	1.56⅜	
August	1.61	1.72½	11½	1.29	1.40½	11⅛	1.46	1.67	
September	1.66	1.80	14	1.28	1.45	17	1.29	1.58½	
October	1.53	1.71	18	[4] 1.23	1.40½	17½	1.13½	1.38	
November	1.25½	1.41	15½	1.13½	1.33⅛	20⅛	1.05	1.32	
December	1.10	1.26½	16½	1.16⅛	1.36½	19⅛	1.24½	1.43⅛	

Month.	1915			1916		
	Winnipeg.[1]	Minneapolis.[2]	Excess of Minneapolis over Winnipeg price.	Winnipeg.	Minneapolis.	Excess of Minneapolis over Winnipeg price.
			Cents.			*Cents.*
January	$1.88	$1.59⅜	21½	$1.92½	$2.15½	
February	1.61½	1.87½	26	2.03½	2.25	
March	1.62½	1.82⅜	19⅞	2.05	2.29	
April	1.76	1.85	9	1.94	2.18	
May	1.79½	1.94½	15	1.83⅛	2.05½	
June	1.64⅜	1.72	7⅝	1.58⅜	1.84⅜	
July	1.51½	1.70½	19	1.58⅜	1.77	
August	1.41	1.60	19	1.86⅛	2.08	
September	1.40⅜	1.66½	25⅛	1.86⅛	2.07	
October	1.60⅜	1.77	16⅝	2.23	2.42	
November	1.65⅛	1.82⅛	17	2.50⅛	2.61⅜	
December	1.83⅛	1.98⅛	14⅝	2.55	2.76⅛	

[1] Quotations for No. 1 Northwestern as given in the annual reports of the Canadian Department of Labor on "Wholesale Prices."
[2] Quotations for No. 1 Northern as given in the annual reports of the Minneapolis Chamber of Commerce.
[3] Excess of Winnipeg over Minneapolis price.
[4] Tariff act approved Oct. 3, 1913.

A comparison of the quotations shows that Minneapolis prices were higher 119 times for a total of 2,098½ points, and that Winnipeg prices were higher 10 times for a total of 64⅛ points. The results of the comparison may be shown in greater detail as follows:

	Number of times.
Minneapolis prices were higher	119
By 5 cents or less	16
By more than 5 and less than 10 cents	9
By 10 to 20 cents	44
By 20 to 30 cents	43
By 30 cents and over	7

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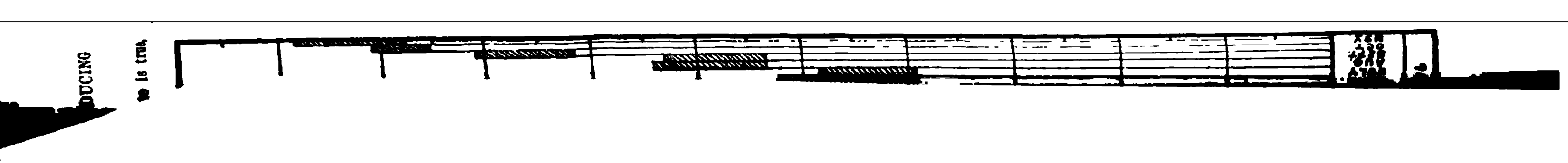

	Number of times.
prices were higher	10
cents or less	5
re than 5 and less than 10 cents	3
o 20 cents	2
the same	1
e not comparable	2

of price differences.—The only years in which the Minne-ice did not regularly exceed the price in Winnipeg were 1907. In these years American production of flaxseed was nd domestic requirements, and prices in Minneapolis were port basis. A good deal of the exported seed was shipped gh bills of lading from the western ports of the Great Lakes. scal year ending June 30, 1906, 2,321,465 bushels of flaxseed, er cent of the total flaxseed exports were so billed, chiefly uluth, enabling the shippers to take advantage of the lower rates. During the following year the amount exported di-rom the Lake region was 3,131,348 bushels, or approximately f of the total exports. In the fiscal year ending June 30, ,448,716 bushels, or one-third of the total flaxseed exports of ntry were consigned directly from Duluth and Chicago.

rly, the flaxseed of the Northwest was on an export basis these years. In Canada, however, the great increase in pro-n had not yet occurred, and exports were exceedingly small. g the Canadian fiscal years (ending Mar. 31) 1906, 1907, and the excess of the Winnipeg over the Minneapolis price per-l the importation of 1,373,611, 2,719,851, and 426,516 bushels, tively, from the United States, notwithstanding the Canadian t duty of 10 cents a bushel. Thereafter, exports from Canada ly increased, while the United States became essentially a flax-importing country, and this is the apparent cause for the higher obtaining at Minneapolis in the later years. From the produc-ections of Canada, equal freight rates applied to Fort William Port Arthur, Minneapolis, and Duluth.

ginning with the calendar year 1908, the monthly quotations Minneapolis were in all cases higher than those of Winnipeg. r January, 1909, when large quantities of foreign flaxseed were ing to the United States, Minneapolis quotations exceeded the nipeg figures 94 times—40 times by 10 to 20 cents and 50 times more than 20 cents. Most of the seed imported from Canada ing 1910 and 1911 entered this country at Buffalo, apparently for eastern oil mills. But after 1911 there was a fairly large and ular movement of Canadian flaxseed to the western ports. In the l year ending June 30, 1912, 1,288,323 bushels entered the United tes through ports of Lake Michigan and Lake Superior, and ross the Minnesota border; in 1913, the amount was 1,214,477

bushels; in 1914, 2,184,940 bushels; in 1915, 1,724,005 bushels; and in 1916, 1,448,275 bushels.

In all these years, except perhaps in 1913, the excess of the Minneapolis price was sufficient (allowing for the fact that the Canadian flaxseed was of a higher grade and worth more per bushel) to permit some importation from Fort William.[12] And it is significant that the amount of flaxseed (474,633 bushels) which moved across the Minnesota border was far greater in 1913 than in previous or subsequent years. It came not from Fort William or Canadian Lake ports, but directly from the western Provinces. This movement permitted a saving of the cost of transporting flaxseed from Fort William to Minneapolis. The costs of transportation from the producing centers of Saskatchewan—the great flaxseed-producing Province—to Fort William and Minneapolis are practically the same. It is obvious, therefore, that flaxseed might profitably be imported into Minnesota from points west of Fort William even though the spread between Minneapolis and Winnipeg quotations would not seem to be sufficiently wide to permit of a movement between the two.

[12] In flaxseed, as in the case of wheat and oats, the disparity between the American and Canadian prices is widest during the winter season of closed lake navigation.

POTATOES.

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POTATOES.

SUMMARY AND CONCLUSIONS.

Owing to the great variations in the annual yield, a comparatively inelastic demand, and a limited keeping period, there is a frequent recurrence of seasons when the prices of potatoes fall below the cost of production or rise to high levels. Furthermore, much local and seasonal price variation is caused by other influences—the great bulk of the commercial crop is produced in widely separated regions; storing, shipping, handling and other expenses of marketing so perishable a product constitute a large portion of the price paid by the consumer. These conditions of distribution complicate the tariff problem, render it difficult to determine the precise effects of import duties, and tend to make foreign competition irregular and decidedly speculative.

But it is clear that the import duty of 25 cents per bushel, in force between 1897 and 1909, proved to be nearly prohibitive in fair or good crop years, except as regards small shipments of high-priced early potatoes, chiefly from the Bermudas. Although the international trade is of considerable dimensions, it is chiefly intra-European. Prior to the tariff act of 1913, large importations into the United States occurred only when domestic crops were short and prices were much higher than in foreign markets; and these importations came chiefly from Europe.

Since September 20, 1912, quarantines have altogether eliminated competition from the countries of largest production. Effective competition is possible only from Denmark and Canada. The latter has enjoyed an indirect preference since July 1, 1917, through the removal of all requirements as to inspection and certification. Relatively small quantities of high-priced early potatoes are also imported without restriction from the Bermudas.

Under the terms of the tariff act of 1913, offering reciprocal free trade in potatoes, free entry is now accorded the product of all these regions. Their shipments to the United States increased in the first year of operation of the 1913 act, which happened to be a year of a short domestic crop; but during the two subsequent war years importations were negligible. From 1914 on, Canada has become the

chief source of imports; her exports to the States, while irregular in volume, have greatly increased. In the fiscal year 1917, when the domestic crop was the smallest for a decade, imports from Canada amounted to 2,844,364 bushels; in 1918 to 977,733 bushels; in 1919 to 3,298,388 bushels, and in 1920 to 6,342,965 bushels valued at $12,160,038.

On November 7, 1918, Canada removed her customs duty, which under the general tariff was 20 cents per bushel. This change was effected under a war measures act, and subsequently was put on a more permanent basis by the amendment of June 6, 1919, to the Canadian customs tariff, allowing free entry to countries according like treatment to the Canadian product; when from other countries the duty was fixed at 20 cents per bushel.

In the quarter of a century from 1891 to 1914 the Canadian acreage in potatoes remained nearly stationary; but at the close of the four-year period 1915–1918, the acreage had risen over 50 per cent. Without doubt this was due in some measure to the world shortage of food, but it is noteworthy that in 1919 the acreage and production were again considerably increased, with a further slight expansion in the 1920 acreage. In the first period production greatly beyond the needs of home markets (which were protected by an import duty) was discouraged by the lack of foreign markets accessible to so bulky and perishable a commodity, and to some extent, likewise, by the import duty and quarantines of the United States. The large increase toward the close of the second period was influenced in uncertain degree by the opening of the American market, higher prices, and the conditions created by the war. The production of Canada is now about one-third that of the United States; nearly three-fourths of it is grown in the eastern Provinces, near some of the largest producing and consuming sections of the United States. As regards the western Provinces, their combined production is only a little over one-half that of the State of Michigan.

Both the United States and Canada import from each other, since 1913 the United States about four times as much as does Canada. There is occasion for a considerable border trade between the two countries by reason of the location of markets and producing sections, local crop and price conditions, and differences in the time of harvest or quality of the crop. The American shipments to Canada consist principally of early or new potatoes; they are, therefore, supplementary rather than competitive, since they appear on the market when old stocks have dwindled and prices are high. The Canadian shipments consist of late potatoes, harvested at approximately the same period as the main crop of the Northern States.

The tariff problem resolves itself principally into the competition, for the Atlantic markets, of the eastern Provinces and the important producing sections of Maine, western New York, and western Michigan. Growers of early and seed potatoes are little concerned. And as for the truck or market gardening sections in the populous centers, the same influences which have aided their development in the face of competition from other sections operate to protect them from Canadian competition.

So far as costs of production *per acre* are concerned, the available data disclose no great difference in favor of producers on either side of the border. But the cost per bushel is the significant basis of measurement; and in bushel costs, Canadian producers enjoy an advantage by reason of higher yields to the acre. With the single exception of Maine, the average yield in nearly every Province is more than one-half again as large as in the adjacent and immediately competing States. This results in lower costs of production per bushel north of the border.

This advantage is partially offset by the higher prices which American producers receive for their product. And while the higher prices were in part due to nearness to larger and more diverse markets, it is possible that the import duties which were in force until nearly the close of the year 1918 were also a factor.

In the prewar period Canada's exportable surplus was not large, hence competition from this source is of importance only if the production of 1918, 1919, and 1920 be maintained or increased. Under free trade such a development is favored by the following conditions:

The neighboring North Atlantic States offer to the Canadians a market which, measured by population, is over three times that of all Canada. Prohibitive import duties and quarantines had closed this outlet until a very recent period.

Freight rates from New Brunswick, Quebec, and Ontario to eastern seaboard points compare favorably with the rates from competing regions. Moreover, shippers in the maritime Provinces can avail themselves of cheaper water transportation.

The climate north of the border is especially favorable for the production of most root crops, while economic and physical conditions limit the range of other crops that can be profitably grown.

Although farmers in the maritime Provinces usually received much lower prices than their neighbors in the States, still they produced a surplus even prior to the removal of the American import duty. Furthermore, they were also able to divide the Cuban market with the American shippers, notwithstanding a preferential tariff in favor of the latter.

In the eastern Provinces, as well as farther west, there are large areas still open to settlement and cultivation. Owing to the large yield of potatoes to the acre, a comparatively small additional acreage will produce a large surplus.[14]

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[14] One hundred thousand acres (about 13 per cent of the area harvested in 1918, which provided a surplus estimated by the Dominion Government to be 20 million bushels), would yield approximately 15 million bushels. Estimating the per capita consumption as being, roughly, 4 bushels, the urban consumption in the North Atlantic States is 80 million bushels.

Some of the more probable effects of such a large increase in imports may be thus summarized:

The marginal areas from which the Eastern States had been drawing supplemental supplies have been moving westward. Important potato-producing regions have been developed in Colorado and Idaho, far distant from the large markets. Freight rates enable the Canadian product to displace that of the West, and free trade would direct the channels of trade southward rather than from west to east.

A large influx of the more cheaply produced Canadian product will evidently tend to lower price levels, especially in the Eastern States. In these States prices would be readjusted more nearly to the levels obtaining farther west, and more nearly to the prices received north of the border. The broadening of the markets and the opening of the adjacent sources of supply tend to lessen the seasonal and local price variations.

There is a considerable margin of avoidable expenditure in the marketing of potatoes; also an economic waste in long-distance transport—both as regards freight charges and losses through freezing and decay. Unrestricted border trade evidently tends to lessen the costs of distribution.

Although imports have found their way chiefly to the East, there is a growing movement toward such cities as Chicago and Detroit, either across the Lakes from Ontario, or from Manitoba. Yields in Manitoba are much larger than in Michigan or Minnesota; costs are less, apparently, and the great cities of the Central States offer a promising outlet. In the western Provinces the transition from grain growing to a more mixed agriculture is already in evidence.

No widespread readjustment in types of production south of the border would be necessitated by an influx of Canadian potatoes, for the American crop occupies only about 1.2 per cent of the cultivated area, and of this small percentage obviously only those sections which are producing late or main crop potatoes at highest cost would be greatly affected.

Finally, cognizance should be taken of the uncertain element introduced by the quarantines and by the European situation. Of the European countries, only Denmark is permitted entry (under inspection); her average net exports during 1911–1913 amounted to about one million bushels. But the quarantines are of uncertain duration. High yields, abundant supplies of cheap labor, and cheaper water transportation may enable these countries, when normal conditions of trade are restored, to compete with Canadian and American potatoes. Prior to 1914 ocean freights from the principal Continental markets to New York were no higher than the rail rate from Maine or Michigan. Imports from these countries were of inferior quality, however, sold at much lower prices than the domestic product, and suffered losses through spoilage or rejection.

TARIFF PROVISIONS WITH RESPECT TO POTATOES.[1]

In the several tariff acts between the years 1883 and 1897 the import duty upon potatoes was alternately 15 cents and 25 cents per bushel

[1] This study refers only to white or Irish potatoes. Canada does not produce sweet potatoes; nearly all of her imports of this product—about 50,000 bushels—are from the United States. Under the Canadian general tariff, sweet potatoes are dutiable at 10

of 60 pounds; it was maintained at 25 cents from 1897 until the enactment of the tariff act of October 3, 1913. In that act potatoes were placed on the free list, with the proviso that against such countries as impose a duty upon the American product an ad valorem rate of 10 per cent should apply (about 4 to 8 cents per bushel under prewar prices). It was not until November 7, 1918, that Canada removed her customs duty, which under the Canadian general tariff was 20 cents per bushel; and this change was effected through an order in council, under authority of the war measures act, primarily in order to facilitate the marketing of a crop 30 million bushels larger than that of any preceding year. Subsequently, by the amendment of June 6, 1919 to the Canadian customs tariff, potatoes were made free of duty when from countries which accord like treatment to the Canadian product; when from other countries a duty of 20 cents per bushel is assessed. Likewise the Netherlands, Belgium, Denmark, and the Bermudas removed their duties on the American product. Between the United States and virtually all nations which our quarantine regulations permit to ship to this country there is thus free trade in potatoes, and imports have been growing in volume.

WORLD PRODUCTION.

Only a small fraction of the world's supply is grown in the United States. Over the greater part of its area the climate is unsuited to potato production, which requires a cool summer with ample moisture fairly well distributed throughout the growing period. Of the world crop of approximately 5½ billion bushels, about 90 per cent is produced in Europe, a little over 6 per cent in the United States, and about 1½ per cent in Canada. The potato is especially adapted to the climatic and economic conditions of northern Europe, where it has become so essential a part of the food supply that large yields are sought and obtained through most intensive cultivation and a great expenditure of labor, seed, and fertilizer. Under favorable conditions it produces a greater amount of food to the acre than perhaps any other staple. Prior to 1914, Belgium alone produced over 50 per cent more than did Canada, and the crop of Germany was over four times as large as that of the United

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cents per bushel. In the American tariff the potato provision covers not only Irish but also sweet potatoes, as well as potato flour, and potatoes, dried, desiccated, or otherwise prepared. Only a very small proportion of the domestic crop is consumed in the potato product industries. Imports of sweet potatoes into the Continental United States are prohibited by quarantines.

For a report concerning potato products (flour, dried potatoes, starch, and dextrine) see "Information Concerning the Domestic Potato-Product Industries," by the United States Tariff Commission, printed for use of the Committee on Ways and Means, House of Representatives, Sept. 4, 1919.

States. European producers have a less fluctuating market than producers in America by reason of the more diverse uses and a surplus of production is more readily absorbed.[2] Only an excessively large crop could cause "dumping" in North American markets. Although Chicago prices were from 65 to 100 per cent higher than those of Berlin during 1910 to 1913, imports to this country from Germany were negligible.[3]

WORLD TRADE.

From 65 to 85 million bushels of potatoes entered into international commerce during the years 1911–1913. Although this trade is chiefly intra-European, there is also a constant movement of several million bushels to the Latin-American countries and an irregular European trade with North America. The volume of the international trade is surprisingly large, in view of the bulky and watery character of the product, its perishability, and the high cost of marketing. Shipment over long distances requires special precautions as to ventilation, light, and temperature. European producers have virtually monopolized the world trade, the United States ordinarily exporting small quantities to neighboring countries where it enjoys special tariff preferences or other advantages. Until recently, high import duties have limited exports to this country except during years of domestic shortage and high prices. In such years large imports were made.

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[2] Of the German crop of 1.8 billion bushels in 1912, about 477 million bushels were used for table purposes, 877 million bushels in feeding live stock, the balance representing the quantities used in replanting, in manufacturing alcohol, starch, glucose, dried potatoes, and potato flour, and the loss through decay. Corn, to which the climate of northern Europe is unsuited, is a cheaper and better stock food, and a cheaper source of alcohol, starch, and glucose. But the broader market for potatoes renders European producers less subject to such violent price fluctuations as occur in the United States and Canada. See note 1, p. 155, regarding domestic potato-product industries.

[3] Average wholesale prices, white or Irish potatoes; per bushel of 60 pounds:

Year.	Chicago (good to choice).	Berlin (table varieties).
1910	$0.43	$0.26
1911	.77	.39
1912	.91	.46
1913	.59	.35

Chicago prices from "Wholesale Prices," U. S. Department of Labor. Berlin prices from "Vierteljahrhefte," converted to bushels of 60 pounds.

MAP 1.—WORLD ACREAGE IN POTATOES. (From Yearbook, 1916, U. S. Department of Agriculture.)

in plant, over 90 per cent of the world's potato crop is now grown in Europe, and almost equaling in value the wheat crop of the world. Germany has as many times as great as that of the United States. Nearly 14 per cent of the per cent in the United States. Russia and Austria-Hungary also each had 1. The Southern Hemisphere has no important potato-raising centers.

TABLE 1.—*International trade in potatoes, 1911–1913.*[1]

[In thousands of bushels.]

Country of destination.	1911	1912	1913
	Exports.		
Argentina	41	793	794
Austria-Hungary	2,145	1,029	1,179
Belgium	7,550	9,460	9,065
Canada	675	935	2,012
China	212	307	346
Denmark	1,478	795	510
France	10,994	8,401	6,653
Germany	20,411	4,608	12,216
Italy	3,156	3,592	5,177
Japan	510	408	428
Netherlands	16,814	17,260	15,279
Portugal	516	429	429
Russia	11,108	9,171	2,957
Spain	1,286	1,718	2,520
United Kingdom	4,362	13,466	911
United States	1,995	1,631	1,817
Other countries	1,642	2,379	1,629
Total	84,895	76,382	63,979
Country of origin.	Imports.		
Argentina	3,418	290	314
Austria-Hungary	4,251	3,452	4,506
Belgium	6,351	3,728	4,683
Brazil	656	1,065	1,096
Canada	388	786	400
Cuba	1,893	1,885	2,225
Egypt	600	647	549
Finland	592	459	365
France	6,790	6,149	8,579
Germany	43,287	30,214	14,038
Netherlands	2,589	1,226	2,041
Norway	419	51	176
Philippine Islands	296	377	330
Russia	265	268	132
Sweden	706	660	660
Switzerland	2,955	3,119	3,443
United Kingdom	5,998	10,708	17,444
United States	1,542	12,409	3,171
Other countries	1,769	2,656	2,203
Total	84,765	80,134	66,374

[1] Yearbook of the Department of Agriculture, 1916.

PRODUCTION IN THE UNITED STATES.

Producing sections.—The bulk of the domestic commercial supply is concentrated in widely separated regions of large-scale production, lying to the north and west of the corn belt and in Maine and New York. In value the potato ranks among the major crops, although only about 1.2 per cent of the cultivated acreage is devoted to its production. Of the national harvest, ranging usually between 350,000,000 and 400,000,000 bushels, the Northern States grow over three-fourths, the South one-tenth, and the West one-eighth.

East of the Rockies the general drift of the trade is southward and eastward. Prices are highest and the per capita consumption lowest in the Southern States.[4]

TABLE 2.—*Production and foreign trade of the United States, 1891–1920.*

[From Yearbooks and Monthly Crop Report, U. S. Department of Agriculture.]

Year.	Acreage.	Production.	Average farm price per bushel Dec. 1.	Imports.	Exports.
				Fiscal year beginning July 1.	
Average by 5-year periods:	*Acres.*	*Bushels.*	*Dollars.*	*Bushels.*	*Bushels.*
1891–1895	2,712,000	212,427,000	0.493	1,804,660	691,772
1901–1905	2,952,000	262,586,000	.584	2,662,122	803,839
1909–1913	3,677,000	356,627,000	.618	3,658,022	1,686,596
1911	3,000,000	29,000,000	.799	1,985	1,237,276
1912	3,000,000	42,000,000	.505	830	2,028,361
1913	3,000,000	33,000,000	.697	963	1,794,073
1914	3,000,000	40,000,000	.497	942	3,135,474
1915	3,000,000	35,000,000	.617	832	4,017,760
1916	3,000,000	28,000,000	1.461	925	2,489,000
1917	4,000,000	44,000,000	1.229	947	3,453,307
1918	4,000,000	40,000,000	1.195	976	3,658,840
1919	4,000,000	35,000,000	1.614	980	3,724,234
1920[1]	3,000,000	42,000,000			

[1] Preliminary estimate.

Large-scale, truck-crop, and early potato production and markets.—The important producing sections are shown in Map 1. For the purpose of this study they may be divided into three groups. The first and by far the most important group comprises the region of large-scale production—Maine, New York, Michigan, Wisconsin, Minnesota, Colorado, Idaho, and central California. The second group consists of the small centers of production around the large cities and in the more densely populated sections. Market gardening and intensive production in these localities are stimulated by accessibility to a quick market and by the greater availability of labor. The third, or southern, group produces chiefly early potatoes grown during the late winter and early spring months. These enter the market during the first half of the year, command higher prices than do late potatoes held over from the preceding harvest, and are usually off the market before the arrival of the late crop. Producers of the early crop would be benefited by free trade with Canada.[5]

A local and seasonal trade.—Although the great bulk of the trade is in the late or main crop, the shipments of seed and early potatoes are of increasing importance. There is a distinct trade in each of

[4] In a study of the food consumption on farms, the per capita consumption was found to average less than 2 bushels per person in North Carolina and Georgia, and over 6 bushels in Wisconsin, New York, and Vermont. (U. S. Department of Agriculture, Farmers' Bulletin 635.)

[5] Early potatoes constitute only about 5 per cent of the total acreage, but about one-fifth of the total car-lot shipments, being grown primarily for the market. Virginia, Maryland, Florida, North Carolina, and Louisiana are the principal producing States.

igures. (From Farmers' Bull. 758, U. S. Dept. of Agriculture.)

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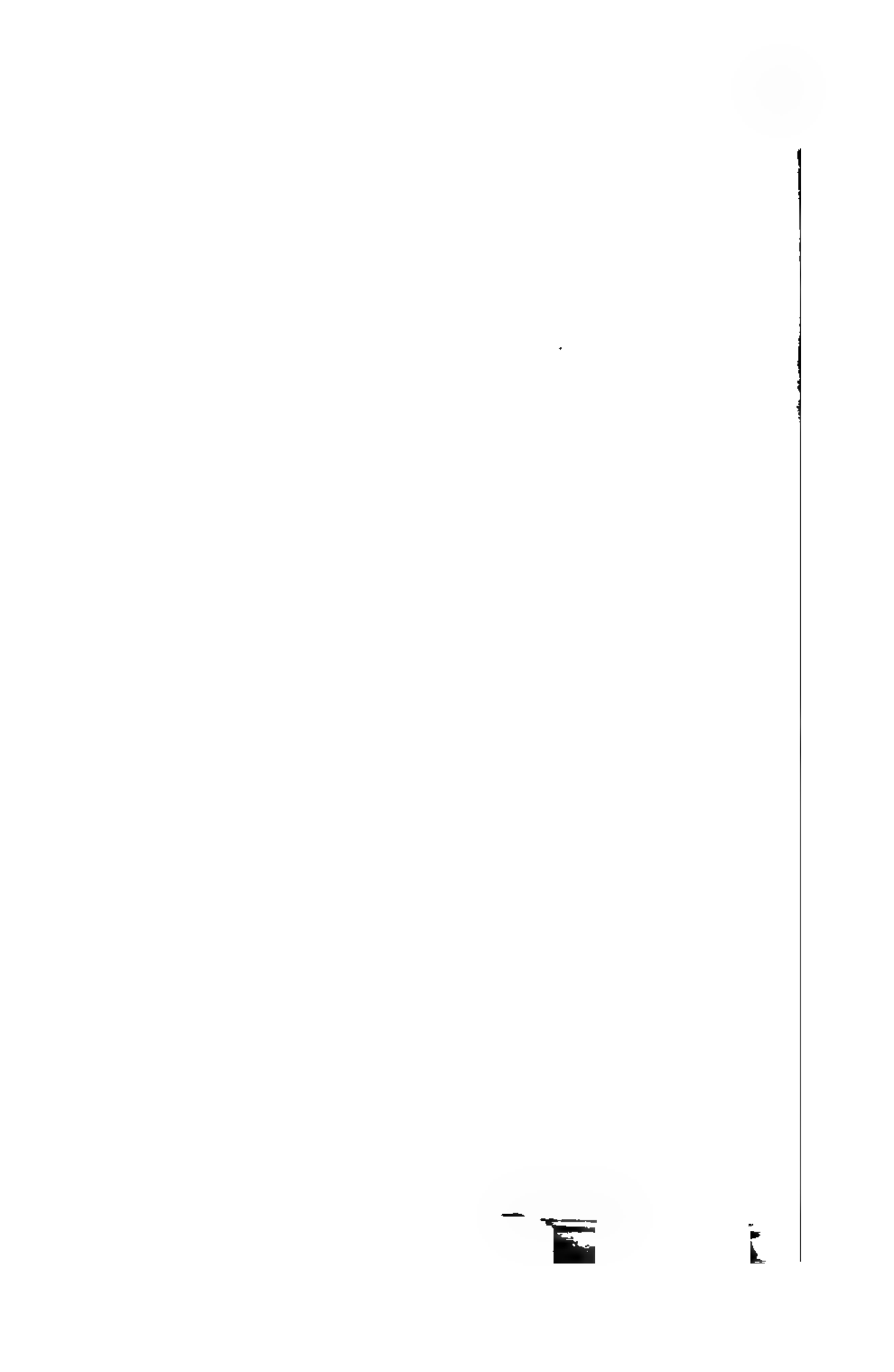

TABLE 3.—*Carloads of potatoes unloaded at 10 large cities, 1916–1919.*

Originating State.	Washington.				Pittsburgh.				Cincinnati.			
	1919	1918	1917	1916	1919	1918	1917	1916	1919	1918	1917	1916
ine	25	8	6	7	90	37	120	317	.....	1	1	4
ssachusetts	.....	.....	.....	.....	2	7	42	5	.....	.....	.....	.....
w York	156	21	10	24	486	126	251	668	27	3	2	19
w Jersey	193	223	130	91	1,129	606	389	884	27	1	66	93
nsylvania	9	1	.....	6	479	121	391	364	3	.....	3	21
aware	.....	.....	.....	.....	3	2	13	28	1	.....	9	16
ryland	19	7	14	7	186	68	199	210	2	3	2	24
ginia	97	102	41	22	969	713	979	1,062	34	3	116	225
rth Carolina	104	124	17	15	186	358	436	277	89	51	108	56
uth Carolina	28	57	28	11	41	108	144	56	.....	4	3	.....
rgia	1	6	.....	21	1	66	21	3	2	30	5	2
rida	22	89	48	.....	135	353	310	64	93	106	[illegible]	56
io	2	3	1	.....	70	29	244	239	11	13	13	53
liana	.....	8	6	.....	3	4	13	55	5	8	8	33
nois	.....	.....	.....	.....	1	11	51	38	11	15	.....	43
higan	217	338	118	202	2,510	1,874	877	2,242	519	278	176	404
consin	101	160	5	4	822	1,488	482	651	680	475	326	153
nnesota	.....	20	1	.....	45	209	49	56	256	202	112	114
rth Dakota	.....	.....	.....	.....	.....	2	1	.....	54	29	10	31
uth Dakota	.....	.....	.....	.....	1	3	15	5	1	3	.....	.....
ntucky	.....	.....	.....	.....	.....	7	26	4	34	11	14	27
nnessee	.....	.....	.....	.....	.....	.....	.....	.....	26	5	14	65
bama	.....	.....	.....	.....	3	4	22	.....	3	124	130	55
ssissippi	.....	.....	.....	.....	1	7	3	7	20	[illegible]	37	7
uisiana	.....	.....	.....	.....	3	123	27	41	22	89	57	49
xas	.....	.....	.....	.....	14	27	4	9	17	13	3	18
lorado	2	2	.....	.....	8	21	19	2	.....	.....	.....	.....
ho	1	3	.....	.....	6	28	21	13	14	17	16	6
ports	2	3	.....	1	57	.....	.....	6	33	.....	3	1
scellaneous	21	38	16	6	80	22	44	24	39	2	156	57
Total	1,000	1,213	439	417	7,326	6,516	5,185	7,328	2,047	1,538	1,573	1,655

Originating State.	Chicago.				St. Louis.			
	1919	1918	1917	1916	1919	1918	1917	1916
aine	59	.....	1	216	.....	.....	.....	.....
w York	23	10	9	89	.....	.....	.....	.....
w Jersey	54	51	187	1,105	2	6	16	36
nsylvania	1	3	63	121	.....	.....	.....	.....
aryland	18	15	152	105	.....	.....	.....	.....
rginia	662	581	1,223	1,411	39	6	72	2
orth Carolina	52	133	22	11	.....	.....	.....	.....
orgia	.....	28	27	24	.....	.....	.....	.....
orida	152	245	339	117	22	28	60	4
diana	14	5	21	25	.....	2	3	9
inois	177	288	166	317	36	28	109	75
chigan	950	543	274	1,155	79	7	20	31
isconsin	4,956	3,901	2,463	3,510	642	468	367	617
nnesota	1,905	1,906	1,194	1,264	1,057	1,068	682	940
wa	25	95	34	37	82	28	50	19
issouri	64	26	24	74	4	9	74	32
orth Dakota	265	217	49	233	47	22	21	124
outh Dakota	72	390	197	427	5	6	10	11
ebraska	67	85	23	77	19	77	45	40
ansas	147	15	30	30	2	3	23	2
entucky	134	115	114	34	.....	1	6	7
ennessee	5	13	52	6	4	3	37	.....
labama	16	69	86	5	2	25	20	6
ississippi	90	131	59	23	8	16	18	13
ouisiana	159	957	315	115	55	107	60	126
exas	308	667	379	294	60	169	107	118
klahoma	207	34	105	191	44	16	22	44
rkansas	128	101	143	225	18	6	64	42
ontana	38	13	21	38	5	1	9	14
Wyoming	3	34	6	16	1	.....	32	4
olorado	241	543	302	144	289	350	312	139
Utah	5	6	6	.....	.....	1	9	1
Idaho	761	508	550	165	285	276	318	276
Washington	99	117	334	284	5	10	119	54
alifornia	153	157	241	15	2	3	34	.....
Imports	105	2	72	33	6	1	9	9
[illegible]	124	[illegible]	226	139	46	6	176	24
	188	12,477	9,609	12,125	2,756	2,730	2,904	2,868

TABLE 3.—*Carloads of potatoes unloaded at 10 large cities, 1916–1919*—Contd.

Originating State.	Kansas City.				Minneapolis.				St. Paul.			
	1919	1918	1917	1916	1919	1918	1917	1916	1919	1918	1917	1916
Florida	5	12	22	10	1	6	2	1				
Indiana											3	3
Illinois	3		3	16		1	19			1	8	3
Wisconsin	45	9	17	26	17	18	35	4	30	20	14	
Minnesota	779	804	578	580	245	241	428	589	56	64	202	45
Iowa	8	23	17	10			8					
Missouri	11	19	74	31	4	4	33	12			7	11
North Dakota	209	202	100	100	21	6	37	39	10	7	9	35
South Dakota	30	48	132	29	2	2	34	30			1	3
Nebraska	302	204	220	460			7	5				
Kansas	93	118	99	43	26		5	30	10		4	9
Tennessee		1	2									
Alabama		2	3									
Mississippi						9	1	2				
Louisiana	37	149	58	80		19	4	4	1	17		
Texas	111	95	110	108	12	36	5	48	3	3	6	11
Oklahoma	83	66	98	154	34	3	15	69	6		13	31
Arkansas	26	61	48	70	5	2	1				2	3
Montana	76	63	75	247	55	3	29	6	8		16	21
Wyoming	126	99	59	3								
Colorado	257	457	338	190								
Utah	7	42	22	1								
Idaho	249	322	138	124	3		16	2	1		1	4
Washington	47	46	216	152	40	5	203	144	1		25	114
California	10	30	29	1	15	39	62	3	11	13	30	
Imports	5		17	5	14		224	54	9		53	37
Miscellaneous		9	60	81	1	3	28	14	2		16	13
Total	2,521	2,602	2,545	2,520	498	397	1,196	1,056	150	125	410	723

NOTE.—A carload of potatoes is equivalent to about 600 bushels.

EXPORTS.

American exports during the fiscal years 1910–1914 ranged from 1 to 2 million bushels. Approximately 60 per cent of this trade is with Cuba; 200,000 to 500,000 bushels—early potatoes chiefly—were shipped to Canada, and the balance of the exports moved to Central America, chiefly to Mexico and Panama. Preferential tariff treatment is accorded the American product in Cuba. Europe ordinarily supplies the South American trade. Since 1914 exports have increased considerably.

TABLE 4.—*Exports of potatoes from the United States, by countries of destination, 1910–1920.*

[From Commerce and Navigation of the United States.]

Fiscal year.	Total.	Cuba.[1]	Canada.	Panama.	Mexico.	All other countries
	Bushels.	*Bushels.*	*Bushels.*	*Bushels.*	*Bushels.*	*Bushels.*
1910	776	507,359	207,764	135,808	62,612	85,433
1911	2,[illegible]57	1,594,396	335,724	146,165	141,771	165,832
1912	1,[illegible]76	658,776	256,373	114,230	97,444	110,453
1913	2,[illegible]51	1,145,627	372,656	169,837	107,121	233,009
1914	1,[illegible]73	961,542	396,870	163,426	85,462	186,773
1915	3,[illegible]74	1,878,358	488,587	164,208	66,247	536,674
1916	4,[illegible]80	2,324,882	230,115	280,726	104,776	1,077,282
1917	2,[illegible]01	1,278,148	574,190	154,268	179,731	302,664
1918	3,[illegible]07	1,887,999	325,482	99,427	252,648	287,751
1919	3,[illegible]40	2,326,178	653,386	64,900	318,119	326,257
1920	3,[illegible]84	2,602,414	502,512	85,091	260,124	273,200

[1] The Cuban general tariff on potatoes is 17.7 cents per bushel. To the United States is granted a preference of 20 per cent, or 3.5 cents per bushel.

IMPORTS AND PLANT QUARANTINES.

Import trade prior to the plant quarantine of 1912.—The import duty of 25 cents per bushel, which was in force during the 16 fiscal years 1898–1913, was equivalent to a protection of approximately 100 per cent of the average cost of production.[6] During the same period wholesale prices in Chicago averaged 55 cents,[7] although at times they dropped to 20 cents or rose to $2. In fair or good crop years, this duty, when added to transportation charges which are high in proportion to the price of the product, proved to be nearly prohibitive. Imports in such years usually amounted to about a quarter of a million bushels (see Table 5), and consisted principally of high-priced early potatoes from the Bermuda and Canary Islands and of a few thousand bushels from Canada. But in the fiscal years 1909 and 1912, when prices rose greatly above foreign levels by reason of short domestic harvests, there were imported 8,383,966 and 13,734,695 bushels, respectively. In those years the bulk of the shipments came from the United Kingdom.

Import trade after plant quarantine act of 1912.—The record importations in the year 1912 were followed by the plant quarantine act of August 20, 1912. Under its authority the Secretary of Agriculture has maintained a complete quarantine since September 20, 1912, against the largest producing countries of Europe, principally because of the danger of importing the potato-wart disease.[8] Shipments from Denmark, Chihuahua and Sonora (Mexico) counties, and from Santo Domingo are permitted, under certification by specifically named and authorized foreign officials and after subsequent Federal inspection at specified American ports of entry. The inspection involves some small expense to the shipper in the form of incidental charges. While similar regulations were at first applied to potatoes from Canada and Bermuda, all restrictions were removed from these countries on July 1, 1917, thus giving them an indirect preference. In the fiscal year 1914, during nine months of which the tariff act of 1913 was in operation, imports rose to 3,645,993 bushels, of which Belgium contributed one and one-tenth million bushels, the Netherlands over 800,000 bushels, and Canada slightly over one million bushels; the product of the United Kingdom, Germany, and Austria-Hungary was quarantined. In 1917 imports from Canada amounted to 2,844,364 bushels; in 1918 to 977,733 bushels; and in 1919 to 3,398,388 bushels; and in 1920 to 6,342,965

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[6] U. S. Department of Agriculture Monthly Crop Report, November, 1911, p. 87. The average cost of production in the year 1909 (based upon detailed estimates of crop correspondents) was found to be 24.6 cents per bushel for the United States, 28.1 cents in the North Atlantic States, 21.4 cents in the East North Central States, and 27.1 cents in the South Atlantic division.

[7] Wholesale prices, Bureau of Labor, Annual Report.

[8] The potato-wart disease affects not only the immediate crop, but also subsequent root crops grown in the same soil. In the territories of Hawaii and Porto Rico, imports, for the local use only, are permitted from all countries, without restriction.

bushels, with an import value of $12,160,038. The Canadian shipments and around 200,000 bushels annually of early potatoes from the Bermudas composed virtually all of the importations during these years. On February 17, 1920, the quarantine was extended to Belgium and the Netherlands. In the fiscal year 1920, 416,880 bushels were imported from Denmark. But the European exports are usually of inferior quality, small and poorly graded, and sell at a material price discount under the domestic product; they also suffer heavy losses through spoilage en route and through rejections by inspectors enforcing the plant quarantine act.

TABLE 5.—*Imports of potatoes into the United States, by countries of origin, 1910–1920.*

[From Commerce and Navigation of the United States.]

Fiscal year.	Total.	Canada.	Bermuda.	United Kingdom.	Netherlands.	Belgium.
	Bushels.	*Bushels.*	*Bushels.*	*Bushels.*	*Bushels.*	*Bushels.*
1910	353,208	97,138	134,864	2,053	17,551	[illegible]
1911	218,984	23,832	101,479	263	9,827	[illegible]
1912	13,734,695	143,059	131,709	12,630,284	121,626	336,29[illegible]
1913	337,230	119,493	141,422	.....	17,607	2,[illegible]
1914	3,645,993	1,025,536	115,728	13,841	803,144	1,16[illegible]
1915	270,942	82,431	128,545	1,609	5,370	.....
1916	209,532	27,576	161,260	10	5	.....
1917	3,079,025	2,844,364	186,775	.....	.....	.....
1918	1,180,480	977,733	195,195	.....	.....	.....
1919	3,534,076	3,298,388	230,107	.....	.....	.....
1920[1]	6,940,930	6,342,965	147,107	9,310	.....	.....

[1] Includes 416,880 bushels from Denmark.

TABLE 6.—*Imports of potatoes for consumption; duties and revenues, 1907–1920.*

[From Commerce and Navigation of the United States.]

Fiscal year.	Rate of duty.	Quantity.	Value.	Duty collected.	Value per unit of quantity.	Actual and computed ad valorem rate.
		Bushels.	*Dollars.*	*Dollars.*	*Dollars.*	*Per cent.*
1907	25 cents per bushel	169,895	187,682	42,474	1.10	22.73
	25 cents per bushel, less 20 per cent.[1]	5,799	4,774	1,160	.82	24.[illegible]
1908	25 cents per bushel	403,685	281,456	100,921	.69	35.[illegible]
	25 cents per bushel, less 20 per cent.[1]	5,057	3,845	1,011	.76	26.[illegible]
1909	25 cents per bushel	8,372,096	3,668,155	2,093,024	.43	57.[illegible]
	25 cents per bushel, less 20 per cent.[1]	9,332	8,392	1,866	.89	22.24
1910	25 cents per bushel	342,703	297,667	85,676	.86	28.7[illegible]
	25 cents per bushel, less 20 per cent[1]	6,875	5,997	1,375	.87	22.9[illegible]
1911	25 cents per bushel	195,893	220,261	48,973	1.12	22.23
	25 cents per bushel, less 20 per cent[1]	12,372	11,710	2,475	.94	21.13
1912	25 cents per bushel	13,724,852	7,163,677	3,431,213	.52	47.90
	25 cents per bushel, less 20 per cent[1]	4,160	3,802	832	.91	21.89
1913	25 cents per bushel	333,637	301,618	83,409	.90	27.65
	25 cents per bushel, less 20 per cent[1]	1,124	965	225	.85	23.65
1914	25 cents per bushel July 1 (Oct. 3, 1913)	23,794	17,666	5,949	.74	33.67
	Beginning Oct. 4, 1913:					
	Free	2,492,108	1,231,524	.....	.49	.....
	10 per cent[2]	1,129,302	516,439	51,644	.45	10.00
1915	Free	140,355	218,638	.....	1.55	.....
	10 per cent[2]	129,355	55,585	5,588	.43	10.00
1916	Free	177,981	311,978	.....	1.75	.....
	10 per cent[2]	31,056	19,633	1,963	.63	10.00
1917	Free	191,641	518,948	.....	2.71	.....
	10 per cent[2]	2,877,373	4,183,460	418,346	1.45	10.00
1918	Free	194,286	366,921	.....	1.88	.....
	10 per cent[2]	978,966	1,081,706	108,170	1.01	10.00
1919	Free	2,962,652	3,069,203	.....	1.04	.....
	10 per cent[2]	571,424	566,352	56,635	.99	10.00
1920	Free	6,913,925	13,438,471	.....	1.94	.....
	10 per cent[2]	26,976	44,264	2,697	1.64	10.00

[1] Reciprocity treaty with Cuba.
[2] Applying to countries imposing a duty on potatoes from the United States.

CANADIAN PRODUCTION AND TRADE.

Recent large increases in production.—The Canadian acreage in potatoes increased but slightly during the 25-year period ending with 1914, remaining around 450,000 acres. In the face of the high American tariff and of European competition in the export trade, production in the Dominion did little more than keep pace with the needs of the protected home market. During the five years 1910–1914 the average annual production was 75 million bushels. But it is to be observed that the acreage planted in 1918, as a result of the opening of the American markets and of war conditions, was 50 per cent larger than in 1914, and the harvest amounted to 105½ million bushels. Again in 1919 the area (818,767 acres) was increased, and the production rose to 131,952,000 bushels. Of the crop of the Dominion, which is now about one-third that of the United States (as compared with about one-fifth in the prewar years), approximately three-fourths is produced in the eastern Provinces. Sections of large production in New Brunswick, Quebec, and Ontario are adjacent to important producing sections in Maine and New York. Freight rates to the great eastern markets and to the American cities along the lake front compare favorably with those from American regions of large production. As the climate is especially suited to potato production and great areas are awaiting cultivation, it is evident that shipments to the States might be greatly increased.[9] It is noteworthy that since 1914 the production of the western Provinces has doubled, though it is still relatively small.

TABLE 7.—*Potato production in Canada, by Provinces, 1891, 1901, 1910–1920.*

[Compiled from the Canada Yearbooks, and Canadian Census and Statistics Monthly.]

	Acres.	*Bushels*	*Bushels*	
1891	450,190	100	82,000	100
[illegible]	448,743	100	36,000	100
[illegible]	465,903	100	48,000	100
[illegible]	479,211	100	63,000	100
1902	484,000	100	45,000	100
[illegible]	473,500	100	04,000	100
[illegible]	475,900	100	11,000	100
[illegible]	478,600	100	10,000	100
[illegible]	473,000	100	72,000	100
[illegible]	657,000	100	58,000	100
[illegible]	736,000	100	36,000	100
1919	818,767	100	80,000	100
1920[1]	784,544	100	67,000	100

[1] Preliminary estimate.

Exports.—In the years 1911–1913 about a million bushels were exported annually, of which Cuba—also the principal market for the American surplus—received about one-half, most of the balance

[9] The potato is a hardy, short-season crop, maturing farther north and at higher altitudes than any other crop except barley and timothy.

moving to Newfoundland and the British West Indies. In the years following the reductions in the American tariff, the exports to these countries were maintained, but the shipments to the United States, while irregular in volume, assumed first place. Between 1917 and 1920 annual exports to all countries were from 3,000,000 to 6,000,000 bushels. Changing quarantine regulations and difficulties of transportation greatly interfered with the trade during the war period, but during the last four years (1917, 1918, 1919, and 1920) shipments south of the border attained higher levels. They constituted about 60 per cent of the total exports.[10] In the Canadian fiscal year ending March 31, 1920, exports rose to 6,327,343, bushels, valued at $8,039,107; of which the United States received 5,480,754 bushels, or more than 86 per cent.

COMPETITIVE CONDITIONS.

Shipments of early potatoes to, and late potatoes from, Canada.—Between the United States and Canada the trade in potatoes, as in most fresh fruits and vegetables, is seasonal and somewhat local in character. Each country imports from the other, the United States about four times as much as Canada since the enactment of the 1913 tariff act. In the small trade prior to that time the American shipments were larger. But while the exports of the Dominion compete with the late or main crop of the border states, the shipments from the States—approximately 500,000 bushels annually—compete but slightly with the Canadian crop. They consist principally of early or new potatoes which reach the Canadian markets during the late spring and summer, prior to the harvesting and marketing of the main Canadian crop, and at a time when stocks are low and prices high. Thus the Labour Gazette, published by the Department of Labour of Canada, reports:

September, 1912.—Potatoes—prices same as last month, imported new stock from the United States being replaced by home-grown supplies.

September, 1913.—New Canadian potatoes are rapidly displacing imported stock in the markets.

November, 1913.—Potatoes up. It is reported that the crop was short in the United States and that supplies were being bought in New Brunswick for export.

Canadian competition affects chiefly Maine, New York, and Michigan.—The bulk of the Canadian exports to the States usually moves from the eastern Provinces to the neighboring United States markets, chiefly by rail through the Maine and New Hampshire customs districts, though some shipments are made via the ocean route from St. John (New Brunswick) and from Halifax. The most important producing section of New England is in Aroostook County, Me.; of New York, in the western counties; and the nearest of the great producing sections of the West are in western Michigan. (See Map 2.)

[10] Canadian fiscal years ending March 31.

In these sections the great bulk of the crop consists of late potatoes. Thus the tariff problem resolves itself chiefly into the competition of these regions with the eastern Provinces for the Atlantic coast markets. As regards this competition, the data which follow indicate that the Canadian producer enjoys important advantages. In the case of other producers in the States it may be noted:

That the markets for American early potatoes would be extended by free trade with Canada.

Because of the difficulty of obtaining sound and disease-free seed potatoes, and the importance of securing such stock, free importation from Canada has certain advantages.

Truck farms and market gardens near the large cities have the advantage of directness of sale to retailers or consumers in the local markets, and also the indirect protection of the high cost of transporting the competitive product. It has been estimated that potato growers receive from one-half to one-third of the price paid by the consumer.[11] Estimates of marketing costs range from 30 to 70 cents; they include the charges of a number of middlemen, the expense of storage, transportation, heating, and lining cars in winter, the cost of barrels, boxes, or sacks, and a considerable percentage of loss through freezing or decay. Therefore such farms and gardens are not dependent on a customs duty.

Western border trade.—There is also occasion for some trade along the western border of the two countries, because of the location of producing regions and markets and because of local crop fluctuations. Thus eastern and western Canada are separated by a sparsely inhabited area several hundred miles wide, and the western Provinces are nearer important producing sections of Minnesota and Wisconsin. In the fiscal year 1917, however, following a short harvest in the Lake and Western States, potatoes moved southward along the whole border. But the combined production of all the western Provinces, though increasing, is as yet little over one-half that of the State of Michigan.

TABLE 8.—*Border trade in potatoes between the United States and Canada, by customs districts, 1914 and 1917.*[1]

[From Commerce and Navigation of the United States.]

Principal customs districts.	1914		1917	
	Imports.	Exports.	Imports.	Exports.
	Bushels.	*Bushels.*	*Bushels.*	*Bushels.*
Total imports from, or exports to, Canada	1,025,536	396,870	2,844,364	574,190
Maine and New Hampshire	882,513	(2)	455,096	3,580
Vermont	.....	.....	81,575	1,133
St. Lawrence	70,236	(2)	54,770	105,367
Buffalo	(2)	145,298	162,403	299,875
Michigan	(2)	(2)	296,121	41,479
Chicago	(2)	(2)	166,989	(2)
Minnesota	(2)	(2)	748,798	(2)
Duluth and Superior	(2)	(2)	43,606	2,497
Dakota	(2)	88,812	18,133	11,030
Montana and Idaho	(2)	(2)	7,760	2,638
Washington	(2)	54,550	156,479	970

[1] Imports and exports at the customs districts along the northern border, as given in the table, may be assumed to be to or from Canada. Shipments via customs districts along the coasts have been omitted since they represent more largely the trade with countries other than Canada.

[2] Not separately stated.

[11] Weld, S. H. D.: Marketing Farm Products.

COMPARATIVE PRODUCTIVITY AND COST.

In Table 9 there have been assembled data regarding yields, prices, wages of farm labor, and land values in the two countries. These data afford a rough indication of the relative advantage of growers on either side of the border.

TABLE 9.—*Comparative productivity and cost of potatoes in the United States and Canada.*

[Sources.—United States: Statistics of production and prices from Yearbooks of the Department of Agriculture. Statistics of farm wages and land values from Monthly Crop Report, Department of Agriculture. Canada: Census and Statistics Monthly, Department of Trade and Commerce.]

[Figures are averages for the 5 years, 1910–1914, unless otherwise stated.]

	Production.	Yield per acre.	Farm price per bushel.	Gross returns per acre.	Average wages of regular farm help per month (including board).[1]		Average value of farm lands, 1919 (plow lands, United States; occupied lands, Canada).
					1910	1919	
	Bushels	*Bushels.*	*Cents.*	*Dollars.*	*Dollars.*	*Dollars.*	*Dollars.*
United States	359,972,000	98	61	59.78	19.21	39.82	74.31
Canada	75,190,000	131	57	74.67	28.98	63.67	52.00
New York	38,088,000	100	64	64.00	23.50	43.30	60.00
Quebec	17,914,000	150	46	69.00	26.12	57.92	72.00
Maine	26,861,000	216	52	112.32	23.50	49.40	37.00
New Brunswick	8,555,000	204	44	89.76	24.12	67.00	32.00
Ohio	14,519,000	84	65	54.60	21.00	39.40	91.00
Michigan	36,117,000	104	45	46.80	23.00	42.00	61.00
Ontario	19,982,000	128	58	74.24	27.99	57.58	66.00
Minnesota	26,009,000	107	47	50.29	26.00	53.70	78.00
North Dakota	5,172,000	97	54	52.38	29.00	56.00	37.00
Manitoba	4,566,000	172	44	75.68	33.34	74.00	35.00
Montana	4,675,000	143	66	94.38	38.00	62.20	34.00
Saskatchewan	4,840,000	167	57	95.19	33.54	76.00	32.00
Alberta	4,145,000	166	47	78.02	34.67	81.33	29.00
Washington	8,167,000	142	58	82.36	33.00	66.30	95.00
British Columbia	3,038,000	210	64	134.40	.....	88.75	174.00

[1] The monthly rate of regular farm help in Canada has been computed from the wages "per year, including board." American figures are "wages per month, with board." No data are available as to the number of working hours per day.

Higher yields in Canada.—A superior climate for potato production confers a decided natural advantage upon Canadian producers, whose returns to the acre are very much larger than the yield in the States. The average yield in Canada during the five years 1910–1914 was 131 bushels to the acre, as compared with 98 bushels in the United States.[12] Except for relatively small areas in the North, the United States is outside of the natural potato-growing belt, as the plant requires for its best development a cool, moist, and equable climate during the growing season. In Maine, where climate and soil are especially favorable, yields higher than in any other State or Province are obtained through intensive and skilled cultivation, and a lavish use of commercial fertilizers. The average yield in Maine was 216

[12] Average yields, 1915–1919: United States, 93 bushels; Canada, 136 bushels.

bushels as compared to 204 in New Brunswick. But in the other border States, where, as in the contiguous Provinces, extensive methods of cultivation are generally followed, yields are much lower than across the border. Thus the yield in Quebec is 50 bushels per acre more than in New York; Ontario, 44 bushels per acre more than in Ohio; Manitoba, 75 bushels per acre more than in North Dakota; British Columbia, 68 bushels per acre more than in Washington.

If the Provinces be compared with States still farther south, their superior productivity becomes even more strikingly evident. In Iowa and Virginia the average yield was only 78 and in Illinois 66 bushels to the acre during 1910–1914,[13] as compared to 128 for Ontario or 172 for Manitoba.

Gross returns per acre.—The higher prices which growers in the border States usually receive, in part because of nearness to markets, lessen to a considerable degree the disadvantage under which they labor. But it should be added that free trade tends to lessen the price disparity between the States and adjacent Provinces. However, if producers' prices be correlated with yields and the gross returns per acre be compared for the period 1910–1914, it will be seen that the Canadian gross returns are higher. The average crop value per acre in Quebec was $69; in Ontario, $74.24, as compared with $64 for New York and $54.60 in Ohio.

Labor, land rentals, and material costs.—Comparable costs of production are not available, but the growing and marketing of potatoes involve heavy expenditures of labor, and the labor charge, as one of the principal items of cost, is, therefore, significant.[14] Table 9 shows that the wages of farm labor are lower in the States than in adjacent and competing Provinces; likewise, equipment and material costs are generally lower. On the other hand, land values are higher in the States. But these differences are unimportant, when calculated on the basis of cost per bushel; clearly the much higher yields to the acre give a very material advantage to the Canadian producer even after allowance is made for the several off-setting factors. Thus potatoes have continued to be one of the major crops of Prince Edward Island, and that island has frequently had a large surplus

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[13] In some of the Mountain States, however, high yields are obtained under irrigation: Idaho, 176 bushels; Utah, 157 bushels.

[14] Costs of producing potatoes fluctuate greatly, not only from section to section and year by year, but even from farm to farm. It is one of the most expensive and risky of the major crops; few crops respond so directly to skilled and intensive cultivation. The grower in Maine, who obtains over 200 bushels per acre through intensive cultivation, does not necessarily produce more cheaply than the Michigan producer, whose average yield, under extensive methods, is approximately 100 bushels. Farm practice as to selection and treatment of seed, cultivation, weeding, the use of commercial fertilizer or manure, spraying, the use of machinery—all these factors influence yields and costs; and there is a further variation according to whether the product is stored or marketed immediately. For these reasons such costs of production as are available are of little value for comparative purposes.

for shipment to the States. And it is significant that the industry should have prospered, notwithstanding the fact that the average producers' price in Prince Edward Island during 1910–1914 was 29 cents per bushel, as compared to 52 cents in Maine and 64 cents in New York.

Freight rates.—The freight rates from Fredericton may fairly be taken to represent those applying from New Brunswick points, and the rates from Presque Isle, those from the contiguous producing section in Aroostook County, Me. Likewise Montreal, Toronto, Buffalo, and Grand Rapids are representative of Quebec, Ontario, the western counties of New York, and western Michigan, respectively. Table 10 presents the freight rates from the above points to Boston, New York, and Philadelphia in the year 1913 and after the rate increases in 1920.

TABLE 10.—*Freight rates per bushel of potatoes (carload lots) from competing sections in the United States and Canada to Atlantic coast markets, 1913–1920.*

[Rates per hundredweight quoted by the Interstate Commerce Commission, converted to bushels of 60 pounds. The minimum carload varies from season to season, and also differs in the railroads north and south of the border.]

From—	To—					
	Boston.		New York.		Philadelphia.	
	1913	September 15, 1920.	1913	September 15, 1920.	1913	September 15, 1920.
	Cents per bushel.		Cents per bushel.		Cents per bushel.	
Presque Isle, Me.[1]	12.6	26.4	19.2	36.9	20.4	39.9
Fredericton, New Brunswick[1]	10.2	23.1	16.8	33.6	17.7	36.9
Buffalo, N. Y.	11.1	23.1	9.6	21.0	9.6	21.0
Toronto	15.9	32.7	14.1	29.4	14.1	29.4
Montreal	12.0	29.4	13.2	27.6	19.5	29.7
Grand Rapids, Mich.	19.2	37.5	17.4	34.8	16.2	33.3

[1] Special or commodity rates apply from Presque Isle, Me., and Fredericton, New Brunswick. Fifth class rates apply from the other points listed.

Producers in western New York (Buffalo) are most favorably situated with regard to all of the seaboard markets. New Brunswick, probably because of the competition of water routes, is on a parity with Buffalo as regards the Boston market, and has lower rates to Boston than any other of the points named. Compared with Presque Isle, the rate from Fredericton is now 3.3 cents per bushel less to Boston, New York, and Philadelphia. The differential of Fredericton over Grand Rapids is 14.4 cents to Boston and only 1.2 cents to New York; but to Philadelphia and southward the Michigan product has the advantage in rates. The differentials in favor of Montreal and Toronto over Grand Rapids are 7.2 and 5.4 cents, respectively, to New York, and about 4 cents to Philadelphia.

omparatively little of the Michigan crop moves to seaboard points, owever; most of it is shipped to Chicago, Pittsburgh, and cities in ichigan (see Table 3).

On the whole, it may fairly be concluded that, so far as freight ates to the North Atlantic seaboard markets are concerned, farmers n the eastern Provinces have an advantage over those in most of the ections of large production in the States, and that this advantage is ost pronounced over producers in the central and western States.

CONDITIONS OF DISTRIBUTION.

In connection with the price comparisons which follow, cognizance hould be taken of the marketing problems. The great variations in he annual yield by which the product is characterized make it the least dependable of the major crops; and these variations, together with a comparatively inelastic demand for table purposes—virtually the only profitable outlet in the United States—cause violent price fluctuations. There is a frequent recurrence of seasons when prices fall blow the cost of production or reach such heights as to cause distress in the large cities. In cities such as New York, Chicago, and Cincinnati the wholesale prices during the year 1910–1913 sometimes fell below 25 cents per bushel, and frequently exceeded $1.50. In the war period Boston quotations for Maine potatoes ranged from 40 cents to $4 per bushel. In April, 1920, because of transportation difficulties, they exceeded $5. The price variations are also local and seasonal in character; prices usually drop steeply in the last two months of the year, after which there is a sharp upward movement until July–August (see chart on p. 172). These conditions of distribution not only render foreign, or at least trans-Atlantic, competition somewhat risky, but also complicate the tariff problem. Some European countries, notably France and Germany, impose seasonal import duties partly to meet the marketing conditions. Shipment by rail over long distances is usually not profitable because of transportation charges that are high in proportion to values. Other unsettling factors are the comparatively limited keeping or storage period, the expense and losses incident to storage, frequent interruptions in transportation, and the lack of such a marketing organization as exists in the grain trade.

Immediate access to markets on either side of the border is evidently of advantage to producers and consumers of both countries. Furthermore, as the factors which influence harvests are apt to vary over so wide an area as is embraced in the growing sections of both countries, the crops tend to supplement each other, and the broadening of the markets would tend in some measure to stabilize prices.

COMPARATIVE PRICES.

The course of wholesale prices at Boston and Montreal, and at S John, New Brunswick (a primary market), has been charted Figure 1, with a view to indicating the relation between these ma kets and the effect of the varying import duties. Nominally, t possible price divergence between these points, when trade was n disturbed by quarantines, transportation difficulties, or war conc tions, is represented by freight charges (see Table 10) plus impc duties—25 cents per bushel to October 3, 1913, 10 per cent ad valore to November 7, 1918, and free thereafter. Only a rough price co parison is possible, however, because of the conditions of distributi and the trade restrictions, and also because of the seasonal chang in the varieties and grades upon which quotations are based.

Evidently the same general influences govern the price fluctuatic in the markets of New England and of the eastern Provinces, for t price curves at Boston, Montreal, and St. John coincide to a notal degree despite the many disturbing factors. It is also apparent tl the ruling markets are in New England, since the consumption the industrial region of which Boston is the center is much grea than that of the adjacent Provinces. It may likewise be noted t prices "break" first and most frequently in Boston, the other m kets responding more slowly; also that the peak usually occurs the summer months and the minimum price around December–Ja ary. During the fall and winter, when the bulk of the New Bru wick surplus is marketed, the divergence between St. John and B ton prices was larger when the 25-cent duty was in force than the subsequent period. But during the summer, when Ameri early potatoes were arriving on the market and stocks of old po toes were low, St. John prices frequently exceeded those of Bost The price disparity between Boston and St. John was most nota during the seasons when Canada was making large shipments to States—September, 1913, to March, 1914, September, 1916, to Mar 1917, and in the shipping season of the 1918 crop.

HAY.

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HAY.

SUMMARY AND CONCLUSIONS.

Canada is the only competitor in domestic markets for hay. Her exportable surplus is produced in the eastern Provinces, and her principal market is in the North Atlantic States. It is in the comparatively limited demand for the better grades of timothy, or of timothy with some mixture of clover, in the cities, towns, and villages of these States that Canadian competition is a factor; and this competition more directly affects farmers in the eastern States and in the surplus-producing North Central region.

Imports during the fiscal years 1911 to 1914, inclusive, ranged from 155,000 to 700,000 tons, valued at from 1½ to 6½ million dollars; and the annual customs revenue from the import duties during the same years was $390,000 to $2,750,000. In the years 1918, 1919, and 1920 her shipments to the States were between 200,000 and 400,000 tons, valued at $4,000,000 to $5,000,000. Hay ranks among the most valuable agricultural imports from Canada.

Although grown primarily for farm consumption, in the Northern States and eastern Provinces it is an important money crop. In some of the eastern States it occupies over two-thirds of the area in crops, yet the production of these States is insufficient to meet requirements for farm and urban consumption. The urban demand is comparatively uniform from year to year, whereas the farm consumption adjusts itself to harvests and varies annually by an amount which sometimes exceeds the entire production of Canada. For farm use, which is ordinarily from 70 to 80 per cent of the national production, a number of substitute feedstuffs are available.

In competing for local markets, domestic producers of hay enjoy a high natural protection apart from import duties, because of its bulk and high costs of transportation. The degree of this protection may be gauged by the fact that in Massachusetts, a State of deficient production, average producers' prices for the years 1907–1916 were nearly twice those of Ohio, a State of surplus production.

The great surplus-producing sections of the United States are in the North Central division; from this region heavy shipments are made to the East, South, and West. In competition with producers of the Central States for southern or western markets, the Canadian growers are at a heavy disadvantage because of distance and higher freight rates. But the situation is reversed so far as the important

North Atlantic markets are concerned. The present duty of $2 per ton offsets, approximately, the advantage of Montreal over Columbus, and of Toronto over Chicago, in shipping to New England points, and somewhat more than offsets it to New York and contiguous territories.

Comparison of the relative advantages of specific States and the adjacent Provinces leads to the conclusion that if an advantage does exist it is on the side of the American producer. Slightly larger yields and lower land values in Canada are offset by higher labor and material costs. Moreover, in the absence of so large and elastic a home market as exists in the United States, foreign outlets for the Canadian surplus tend to establish the level of Canadian prices. Farm prices in Quebec are lower than in New York State, and in Ontario lower than in Ohio.

As the surplus of the eastern Provinces moves to the neighboring States, prices in Canada are on a lower level than in those States by an amount roughly approximating shipping costs plus the American import duty. The price disparity was greater when the American tariff was $4 per ton than when it was $2. In the year immediately following the reduction of the import duty, prices in Boston remained nearly stationary, while Montreal prices rose by approximately the extent of the remission. Although the hay crop of both countries was short in the corresponding harvest year, 1913, exports to the States continued.

Under the conditions existing before and after the reduction of the American import duty, Canadian exports were not of sufficient volume appreciably to affect the level of American prices. The reduction of $2 per ton does not appear to have lowered prices in the United States, but merely to have raised the prices received by Canadian producers—and the prices paid by Canadian consumers.

Finally, while it would be rash to predict the effect of free trade and unrestricted imports, or even of the present duty when normal conditions of trade are restored, some of the more probable consequences may be indicated. An increase in shipments from Canada to the Eastern States, a readjustment of the channels of trade according to freight rates,[1] and some effect upon the level of American prices would be expected. But relative to the volume of American production and consumption of hay or of timothy, the increase in imports would not be likely to be important.[2] Nor does the effect upon prices promise to be very great. It is probable that prices in New England, which are higher than in any other part of the United

[1] See freight rates, p. 186.

[2] American production, 100 to 110 million tons; timothy alone, about 20 million tons; timothy and clover mixed, about 20 million tons. Canadian production of hay and clover, 12 to 15½ million tons; maximum Canadian exports, 700,000 tons.

States except perhaps in Florida, might be somewhat reduced. But the local character of the hay trade and the fact that costs of production do not differ materially on either side of the border, preclude, in the long run, a material and general reduction of prices solely from Canadian competition. The Dominion is one of the greatest exporters of dairy products in the world. The greater comparative advantage of dairy and other live-stock products that can be shipped more cheaply, and which would also be affected by free trade or by higher prices for hay, would militate against a very large increase in exports, except in years of local or general crop shortage in the United States.

IMPORTS AND RATES OF DUTY.

In the tariff acts of 1883, 1890, 1894, and 1897 the American import duty on hay was alternately $2 and $4 per ton. It was maintained at $4 per ton from 1897 to 1913. On an ad valorem basis this was equivalent to a rate of from 41 to 69 per cent. In the tariff act of October 3, 1913, the duty was restored to $2, which is the rate that Canada, under its customs tariff of 1907, applied on shipments from the United States.[3] Canada is the only competitor in domestic hay markets; under normal conditions nearly her entire surplus is shipped to the States. In the fiscal years 1911 to 1914 the value of imports ranged from 1½ to 6½ million dollars; in 1920 it amounted to over 4⅓ million dollars. Ordinarily hay ranks among the principal imports from the Dominion.

TABLE 1.—*Imports of hay for consumption; duties and revenue, 1910–1920.*

Fiscal year.	Rate of duty (per ton of 2,240 pounds).	Quantity.	Value.	Duty collected.	Value per unit of quantity.	Actual and computed ad valorem rate.
		Tons of 2,240 lbs.	*Dollars.*	*Dollars.*	*Dollars.*	*Per cent.*
1910	$4	96,763	775,264	387,054	8.01	49.93
1911	$4	336,821	2,545,914	1,347,282	7.56	52.9[illegible]
1912	$4	699,214	6,472,376	2,796,855	9.26	43.21
1913	$4	155,382	1,504,319	621,527	9.68	41.32
1914	$4 to Oct. 4, 1913	26,344	219,183	105,376	8.32	48.08
	$2 thereafter	144,516	1,414,115	289,032	9.79	20.44
1915	$2	20,203	229,068	40,406	11.34	17.64
1916	$2	43,186	679,412	86,372	15.73	12.71
1917	$2	58,269	628,218	116,538	10.78	18.55
1918	$2	410,793	4,581,272	821,586	11.15	17.93
1919	$2	276,602	3,678,253	553,204	13.30	15.04
1920	$2	224,952	4,236,815	449,904	18.83	10.61

QUARANTINE REGULATIONS.

Apart from other limiting factors, competition from any country other than Canada is rendered unlikely by quarantine regulations. These regulations, aimed at preventing the entry of infectious diseases of animals, specify that imports from countries other than Canada, Mexico, and the United Kingdom must be disinfected on board vessel or conveyance at the expense of the owner and stored in quarantine for a period of three months.[4] Such restrictions are prohibitive.

[3] The Canadian duty is somewhat higher, however, as it is based on a ton of 2,000 pounds, while the American unit is a ton of 2,240 pounds.

[4] Quarantine regulations for hay are issued by the Secretary of Agriculture, under an act of Congress approved Feb. 2, 1903, entitled "An act to enable the Secretary of Agriculture to more effectually prevent and suppress the spread of contagious and infectious diseases of live stock, and for other purposes."

TABLE 2.—*Imports of hay into the United States, 1910–1920,*[1] *by countries of origin.*

[Tons of 2,240 pounds.]

From—	1910	1911	1912	1913	1914	1915	1916	1917	1918	1919	1920
	Tons.	*Tons.*	*Tons.*	*Tons.*	*Tons.*	*Tons.*	*Tons.*	*Tons.*	*Tons.*	*Tons.*	*Tons.*
Canada	96,507	336,538	698,738	155,230	169,344	19,521	42,847	57,808	406,148	276,308	224,884
All other countries	322	219	266	1,093	1,442	666	337	339	2,590	1,140	68
Total	96,829	336,757	699,004	156,323	170,786	20,187	43,184	58,147	410,738	277,448	224,952

[1] Fiscal years ending June 30.

PRODUCTION AND TRADE OF THE UNITED STATES.

Production.—In value and acreage hay usually ranks as the second of the American crops—a farm value of over a billion dollars and an area of about 70 million acres. No other crop is so generally produced. But the great bulk of it is retained for farm consumption, only about one-fourth of the crop being sold. The growing of market hay is carried on principally in the region of more intensive live-stock production; that is, in the North Central and North Atlantic States. It is this section that Canadian hay competition chiefly concerns. Of the national crop of around 100 million tons, the Northern States east of the Great Plains produce about three-fourths, the West about 13 per cent, and the South 12 per cent. In local importance, though not in volume of production, the crop ranks highest in the North Atlantic States, which, with Michigan and Wisconsin, are sometimes designated as the "hay and forage province." In some of these States hay occupies nearly three-fourths of the area in crops. The location of the principal producing regions is indicated on Map 1, while Table 3 shows the rapid increase in the national production and the relative importance of the principal varieties.

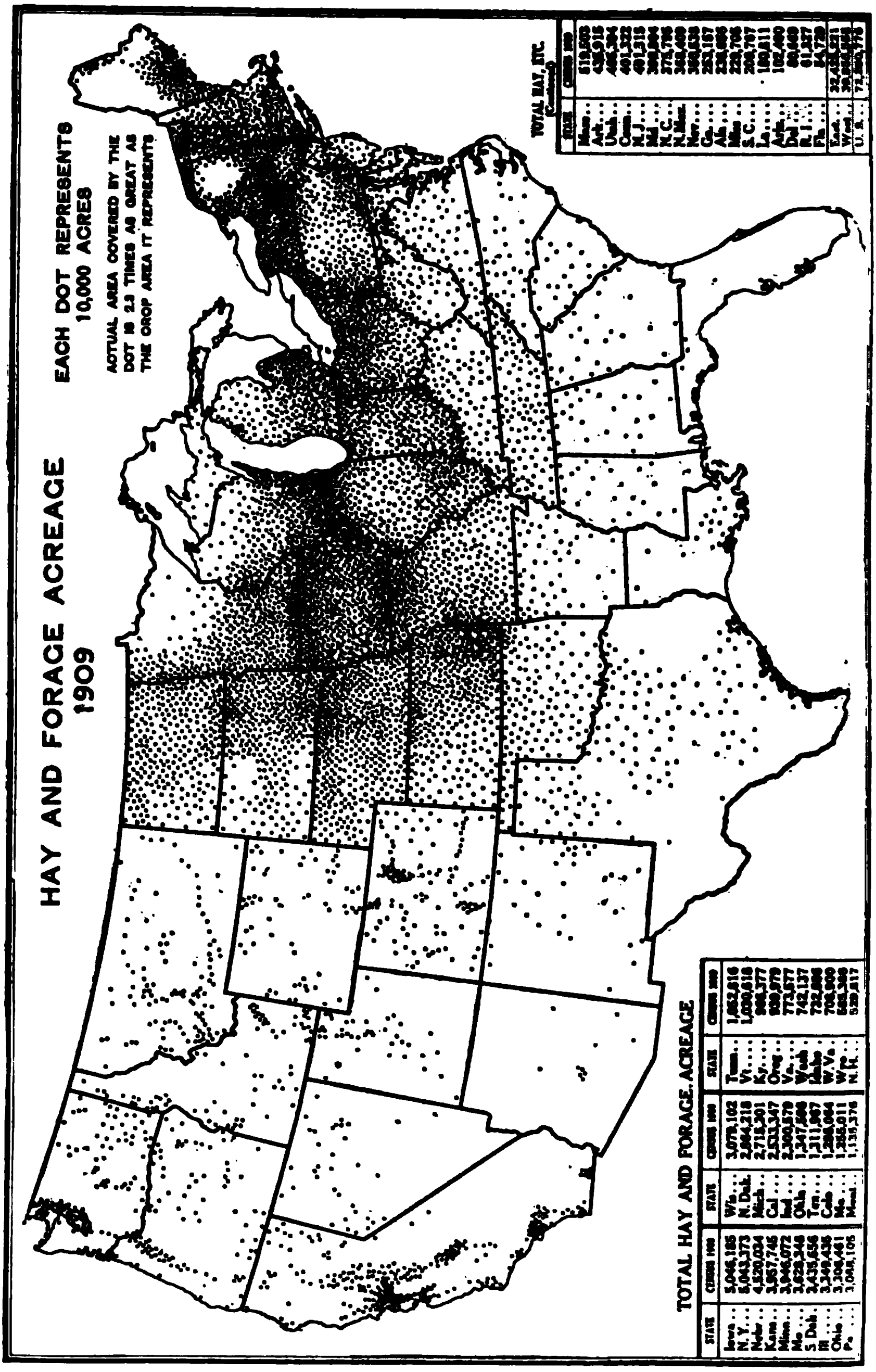
TABLE 3.—*Production of hay in the United States, 1899–1919.*

[Tons of 2,000 pounds.]

	1899 (census).	1909 (census).	1915 (estimate).[1]	1916 (estimate).[1]	1917 [1]	1918 [1]	1919 [1]
Total hay production	71,112,709	87,216,351	106,716,000	110,992,000	98,439,000	91,139,000	108,666,000
Timothy alone	(2)	17,985,420	19,054,000	22,687,000	20,311,000	16,635,000	14,487,000
Timothy and clover mixed	(2)	24,748,555	18,713,000	21,307,000	11,813,000	16,820,000	19,943,000
Clover	5,167,188	3,158,324	12,527,000	14,145,000	18,361,000	13,699,000	13,138,000
Alfalfa	5,220,671	11,859,881	18,562,000	16,655,000	17,386,000	15,071,000	23,850,000
Other tame hay [2]	43,439,992	11,080,597	16,369,000	16,398,000	15,437,000	14,435,000	19,908,000
Total, tame hay	53,827,851	68,832,777	85,225,000	91,192,000	83,308,000	76,660,000	91,326,000
Wild, salt or prairie and other [2]	17,284,858	18,383,574	21,491,000	19,800,000	15,131,000	14,479,000	17,340,000
Total acreage	58,583,876	68,227,310	71,761,000	72,356,000	70,334,000	70,234,000	73,688,000

[1] Monthly Crop Report, U. S. Department of Agriculture, December, 1916–1919. Except for census years, prior to 1915 no statistics of the production of prairie hay are available.

[2] "Other tame hay" in 1899 includes timothy, also timothy and clover mixed.



MAP 1. DISTRIBUTION OF HAY AND FORAGE ACREAGE IN THE UNITED STATES.

Exports.—Exports of hay from the United States are relatively insignificant; their volume and destination are given below. In value they ordinarily amount to between $1,000,000 and $2,000,000. The shipments to Canada and the Philippines appear to have originated in the Pacific States.

TABLE 4.—*Exports of hay from the United States, 1910–1920.*[1]

[Tons of 2,240 pounds.]

Exported to—	1910	1911	1912	1913	1914	1915	1916	1917	1918	1919	1920
Canada	6,141	14,196	19,092	33,236	17,417	13,893	12,709	4,107	2,918	9,986	40,289
Mexico	12,073	16,098	13,987	13,040	15,477	9,410	20,635	26,070	5,830	7,926	11,106
United Kingdom	17,311	11,836	6,521	2,013	352	11,978	9,104	529	2,155	334	2,150
Philippines	12,916	8,108	5,034	4,830	7,298	10,008	4,657	840	2,069	425	1,098
All other countries	5,566	5,484	5,146	7,594	9,607	60,219	131,191	83,983	17,172	10,227	5,317
Total	55,007	55,223	59,730	60,720	50,151	105,508	178,336	85,529	30,145	28,808	59,948

[1] Fiscal year ending June 30.

PRODUCTION AND TRADE OF CANADA.

Production.—Next to wheat, hay is Canada's most valuable crop. In the eastern Provinces it ranks first in value; and in these Provinces, as in the States to the south, the dominant varieties of tame hay are timothy and clover, sown either separately or in a mixture.

No great increase has taken place in the Canadian production since 1910, in contrast to the development in grain crops. The record crop of 1919 amounted to 16½ million tons, or about 18 per cent of the American production of tame hay in the same year. Approximately three-fourths of the Canadian hay is produced in Ontario and Quebec. In these two Provinces, where also the major part of the live stock of Canada is raised, dairying is the most important agricultural industry; and as they are the most populous part of Canada, the needs of the cities add to the demand. Hay is an important source of revenue to the farmers in these Provinces. The Canadian census of 1911 reported that in Quebec 61.3 per cent of the area in crops was devoted to its cultivation; in Ontario the percentage was 34.5.

TABLE 5.—*Acreage and production of "hay and clover" in Canada, 1891–1920.*[1]

Year.	Canada.			
	Acreage.	Production.	Ontario production.	Quebec production.
			Short tons.	*Short tons.*
1891	00	)	3, 000	2,243,000
1904	00	)	2, 000	2,582,000
1910	00	)	4, 000	4,727,000
1911	00	)	4, 000	6,260,000
1912	00	)	5, 000	3,792,000
1913	00	)	3, 000	4,060,000
1914	00	)	3, 000	3,575,000
1915	00	)	4, 000	3,682,000
1916	00	)	6, 000	5,224,000
1917	00	)	5, 000	5,065,000
1918	00	)	4, 000	6,800,000
1919	00	)	5, 000	6,449,000
1920[2]	00	)	5, 000	6,449,000

[1] Between 200,000 and 500,000 tons of alfalfa were produced annually in addition to the above.
[2] Preliminary estimates.

TABLE 6.—*Exports of hay from Canada, 1910–1920.*

Limitations upon Canadian exports.—It is difficult to judge from the statistics of exports the potential competition from Canada under free and unrestricted trade. An insignificant trans-Atlantic trade, import duties in the States amounting until 1913 to approximately 50 per cent ad valorem, heavy shipping costs, the uncertain conditions created by quarantines—all these factors discouraged production beyond the needs of the home market. In the years following the reduction in the American import duty war demands absorbed Canada's surplus. Yet she has usually had an exportable surplus; and that surplus, being produced in sections favorably situated with respect to some of the largest markets in the States, may be greatly expanded if profitable outlets be opened through the removal of the United States import duty. The data which follow bear upon the character of this competition and upon the relative advantages of producers in both countries.

It should be added that although the exports from the Dominion have been unimportant in comparison with the volume of American production, they are of considerable local significance by reason of the fact that they compete almost entirely in the cities and villages of the North Atlantic States, and especially of New England, with the local product and with part of the surplus of the East North Central States. The imports consist mainly of the better grades suitable for the urban demand.

CHARACTER OF THE HAY TRADE.

Demand for different kinds.—Most farmers raise hay for their live stock and sell only the surplus. The growing of hay for the market as a distinct branch of agricultural production has arisen principally from the demand for horse feed in cities, towns, and villages.[5] Different types of hay are in demand for working animals and for others. It is chiefly in the demand for timothy in the urban markets of the East that Canadian competition is a factor; so far as farm consumption of imported hay is concerned, the difference between farm and market values, added to costs of baling and hauling, are prohibitive, except in years of great shortage. For feeding horses, timothy, or timothy with some mixture of clover, is the standard hay, and ordinarily it yields the top prices in eastern and central markets. On the other hand, this variety is deficient in flesh-forming constituents, and as compared to alfalfa is of low nutritive value for meat or milk animals. City markets usually, therefore, make demands as to varieties and qualities, such as color and appearance, the absence of which will not greatly impair the value of the product for farm consumption. In consequence, dealers frequently experience difficulty both in obtaining sufficient supplies of the better grades and in disposing of the poorer grades. Only to a very limited extent does a city market exist for the lower grades, except in years of crop shortage and high prices.

Present tendency in the trade.—A change appears to be taking place in the character of the hay trade in the United States. The substitution of motor cars and trucks for horses, the increasing use of tractors, and the large export of horses since 1914 are reducing the consumption of timothy, particularly in the cities. But the tonnage of shipments of other varieties is increasing, because of a greater demand for the milk and beef producing kinds—alfalfa, clover, and mixed hays. The drift toward feeding and more intensive methods in western stock raising, and toward mixed farming elsewhere, has also been a factor. High prices for live stock and live-stock products have recently made it profitable for farmers in some regions to buy hay in other regions and feed more of it than they produce. City markets also report larger receipts, of varieties other than timothy, for consumption in the dairy industries and truck farms of adjacent sections rather than in the city itself. This change in the hay trade indicates that the market for timothy—in which Canadian competition has hitherto been most strongly marked—is a declining one.

[5] The Federal census of 1909 reported 3½ million horses and 2 million head of cattle "not on farms."

Table 3 shows the rapid increase in the production of alfalfa and clover since 1899. Virtually all of the domestic supply of timothy and clover is grown in the region east of the Great Plains, and north of the Virginia-Kansas line. Alfalfa is the principal western hay.

FARM AND URBAN MARKETS.

An indication of the relative importance of farm and urban consumption—the competitive and noncompetitive markets—is afforded by estimates of the percentage of the production "fed to stock owned on farms producing it."[6] For the United States as a whole, this amounted to about 73 per cent in each of the years 1914, 1915, and 1916. Again, estimates of the quantity of hay annually baled indicate the approximate proportion of the crop that enters channels of trade. The proportion baled was reported in 1916 and 1917 to be approximately 24 per cent of the crop. But to this should be added a considerable but unknown amount of unbaled hay that goes to closely adjacent markets.

The annual consumption of the United States tends to adjust itself to harvests, and varies by as much as 15 million tons, which is more than the total average annual production of Canada. But the variation is found almost entirely in the farm consumption; the urban demand and consumption remain comparatively uniform from year to year. This is shown by the receipts at several of the largest eastern markets. These receipts are substantially the consumption: for reshipments, when reported, are relatively unimportant.

TABLE 7.—*Receipts of hay at principal Eastern markets, 1906–1911.*[1]

[Tons of 2,000 pounds.]

	1906–7	1907–8	1908–9	1909–10	1910–11
New York	381,023	341,285	339,299	349,347	359,[illegible]
Boston	138,510	142,920	134,060	136,940	139,[illegible]
Philadelphia	100,173	106,662	92,172	90,767	91,[illegible]
Baltimore	79,866	56,031	60,011	60,646	61,[illegible]

[1] From Annual Report, The National Hay Association, Inc., 1911. The increase in the number of motor vehicles does not appear to have decreased hay shipments to these markets. According to the available data, receipts in later years were maintained at substantially the same levels as during 1906–1911.

A short harvest and higher prices will draw to city markets grades that in good years for hay it is difficult to sell; when such shortages occur the farmer can substitute, for his own use, coarse fodder, straw, silage, and root crops. Consequently, farm consumption varies greatly according to local harvests, conditions of pasture, live-stock conditions, and the length and severity of winters. Thus a severe or

[6] Monthly Crop Report, U. S. Department of Agriculture, May, 1916, and October issues, 1916–17.

long winter, or a drought in the western stock-raising States will result in large shipments of hay to these sections. Such occasions are not infrequent.

COMPETITIVE CONDITIONS: UNITED STATES AND CANADA.

Position of each country in respect to markets.—The North Central division is the great surplus-producing section of the United States; from this region heavy shipments are made to the South and East, and some movement also takes place to the West. A brief discussion of the position of producers in both countries with respect to these markets may serve to outline the tariff problem.

Southern markets.—Over a million tons of hay, valued in 1914 at about 16 million dollars, are shipped to the cotton States annually; this is about 21 per cent of the consumption of those States.[7] In competition for the Southern markets, it is evident that the Canadian producers are at a permanent and heavy disadvantage in higher freight charges. In the case of the central markets Canadian competition is difficult for the reason that in the Central States west of the Mississippi approximately 10 millions tons of wild or prairie hay are cut annually and are a cheap source of supply.

Western markets.—As regards the western markets, Canadian shippers labor under similar disadvantages. In western Canada an increase in hay production is contingent upon the development of live-stock industries, rather than upon free trade in hay. When winters are severe and prolonged, or a shortage of hay occurs, large quantities are sometimes shipped to the range States from other sections. But under such conditions it is obvious that the great stock-raising interests of these regions are best served by an unrestricted border trade.

Eastern markets: Requirements.—The volume of shipments to the Atlantic States is indicated by receipts at four of the largest cities (see p. 184). New York, Boston, Philadelphia, and Baltimore receive over 600,000 tons exclusive of the receipts by wagon roads, whereas, according to the census of 1909, sales of the local product amounted to but 272,594 tons in the New England States, and to 1,116,016 tons in the Middle Atlantic States.[8]

Advantages of eastern producers.—So far as these markets are concerned, local producers and shippers from the Central States are differently affected. Eastern growers have a natural protection in the heavy freight charges on the competitive product. Computing upon the basis of market values in 1920, shipping costs by rail from Chicago to New York, in carload lots, are approximately five times those of an equal value of wheat. The importance of this protection

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[7] Agricultural Outlook. U. S. Dept. of Agriculture, Dec. 31, 1914.
[8] "Sales of Feedable Crops," vol. 5, Thirteenth Census.

Canada, for the year 1915 only:[10] Alberta, $7.60; Saskatchewan, $8.39; Manitoba, $9.45; Ontario, $14.06; Quebec, $15.89; New Brunswick, $14; Nova Scotia, $13.33.

In the North Atlantic States hay has become one of the principal money crops; in some of these States it occupies over two-thirds of the cropped area. The production of New York—about 6 to 7 million tons—is larger than that of any other State; but still the crop of the Eastern States is insufficient to meet requirements for urban consumption and for the intensive live-stock industries.

FREIGHT RATES.

The tariff problem evidently resolves itself principally into the competition of shippers in the Central States and in eastern Canada for the North Atlantic markets. Their relative position as regards freight rates is shown in Table 8. Current rates (1920) are given, and also the rates in 1912.

TABLE 8.—*Freight rates per ton*[1] *of hay, carload lots (machine-pressed bales); "current" rates, effective September 15, 1920; and rates 1912–1914.*

From—	To—					
	Boston and New England points.		New York and contiguous territories.		Philadelphia.	
	Current rates (September 15, 1920).	1912–1914	Current rates (September 15, 1920).	1912–1914	Current rates (September 15, 1920).	1912–1914
Montreal	$7.70	$2.60	$3.40	$1.30	$2.90	$1.30
Toronto	10.90	5.20	9.20	4.70	9.60	4.70
Columbus, Ohio	10.50	5.20	9.70	4.60	9.10	4.30
Chicago	13.40	6.60	12.60	6.00	12.00	5.60

[1] In the domestic trade the ton is of 2,000 pounds, in the export returns, 2,240 pounds.

These rates indicate that under free trade the Canadian product, so far as transportation is concerned, would be able to displace the western hay in the Atlantic markets north of Philadelphia. From Montreal to New York and Boston the rate is $1.30 and $2.80 per ton

[9] Compiled from Yearbook, 1916, U. S. Department of Agriculture.
[10] Canada Yearbook.

ess than from Columbus, Ohio, and about $4.20 and $5.70 per ton less han from Chicago. It should be borne in mind that by far the argest part of the surplus hay region of the United States is west of Columbus, while the surplus of Canada is grown east of Toronto. A ompetitive freight rate enables Toronto to reach at the same cost New York and contiguous territories and Baltimore and Philalelphia. In this connection it is well to note that the competitive urplus of Canada is elastic; thus exports to the States increased lightly during the months following the reduction of the duty, alhough the crop was about 1½ million tons less than in the preceding ear.

COMPARATIVE PRODUCTIVITY AND COST.

As conditions of timothy and clover production in the eastern Provinces are broadly comparable with those in the adjacent States, an approximation of relative advantages may be obtained through such data as have been collated in Table 9. Because of the diversity of conditions in the States it seems preferable to compare specific States with adjacent and immediately competing Provinces, New York with Quebec, and Ohio with Ontario. In these States and Provinces the same kinds and qualities of hay are produced.

TABLE 9.—*Comparative productivity and cost: United States and Canada.*

[Sources.—United States: Statistics of production and prices from Yearbooks of the Department of Agriculture. Statistics of farm wages and land values from Monthly Crop Report, Department of Agriculture. Canada: Census and Statistics Monthly, Department of Trade and Commerce.]

[Figures are averages for the five years, 1915–1919, unless otherwise stated.]

	United States.	Canada.	New York.	Quebec.	Ohio.	Ontario.
Average production of tame hay (short tons)	85,669,000	14,025,000	5,232,000	5,444,000	4,256,000	5,121,000
Average yields per acre (short tons)	1.56	1.57	1.43	1.54	1.44	1.60
Average producers' price per short ton	$15.84	$14.65	$16.72	$14.55	$17.26	$13.48
Average wages of regular male farm help, per month, including board, 1919[1]	$39.82	$63.66	$43.30	$57.92	$39.40	$57.58
Average value of farm lands, 1919 (plow lands, United States; occupied lands, Canada)	$74.31	$52.00	$60.00	$72.00	$91.00	$66.00

[1] The monthly rate of regular farm help in Canada has been computed from the wages "per year, including board." American figures are "wages per month, with board." No data are available as to the number of working hours per day.

Hay is probably the cheapest crop to produce; machine and horse labor can be applied to virtually all processes connected with its production; and when sown with grain—a general practice—there is no direct labor cost for preparing or cultivating or for seeding. It requires a minimum of labor and supervision, except in harvesting, and while the cost of good grass seed is rather high, the initial expense may be distributed over a number of years.

Yields in tons to the acre are slightly higher in Canada than in the United States; higher also in Quebec than in New York, and in Ontario than in Ohio. Land values are also materially lower in Canada. On the other hand, while it may fairly be assumed that the efficiency of labor is approximately the same, wages of regular farm labor (male) are considerably higher in Canada. Costs of agricultural machinery and other equipment are usually higher in the Dominion. Under normal conditions—that is, prior to the year 1914—the farmer of New York and Ohio received a higher price per ton of hay than the farmer in Quebec and Ontario (the corresponding Provinces) because of his more favorable position with regard to southern and eastern markets. The available data indicate rather conclusively that the advantage is not with the farmer of the Dominion in a comparison of cost and market conditions.[11]

PRICES: AMERICAN AND CANADIAN.

Comparative market prices.—Boston and Montreal have been selected for the comparison of wholesale prices, partly because of the importance of these markets and also for the reason that most of the Canadian exports to the New England States pass through the Montreal customs district. The grade of hay selected for this comparison, No. 1 Timothy (baled), is substantially the same in both cities.[12]

As the chief market for the Canadian surplus is in the eastern cities, it follows, of course, that ordinarily the prices in those cities tend to establish the general level of hay prices in eastern Canada, and that at points in Canada and the United States with equal freight rates to markets such as New York or Boston the American shipper would receive for the same grade a price higher than that of the shipper across the border by the amount of the duty. Canadian dependence upon the American markets is strikingly shown by the continuance of lower price levels in Canadian markets during the shipping season of the 1913 crop, since in that year an exceptionally small hay crop was harvested in the Provinces, the shortage being several times the volume of the normal exports to the States. It is also notable that although the price received for the exportable

[11] Of course, if Ontario were compared with North Dakota, for instance, the advantage would be in favor of Ontario, as farm wages increase and hay prices decrease moving westward from New York to North Dakota, both in the border States and Provinces.

[12] Under the rules of the National Hay Association, Inc., of the United States, No. 1 Timothy is defined as "timothy with not more than one-eighth of clover or other tame grasses mixed, may contain some brown blades, must be proprely cured, of good color, sound, and well baled. Under the Canadian inspection and sale act, No. 1 Timothy "shall be Timothy with not more than one-eighth clover or other tame grasses mixed, of good color, sound, and well cured."

UNIV. OF MICH.

tends to regulate Canadian prices, that surplus has consti-
nly a small part of the total production of the Dominion.

).—Wholesale prices per ton of No. 1 timothy hay at Boston and Montreal, 1912–1915.[1]

ore and after reduction of duty from $4 to $2 per long ton. Tariff act of Oct. 3, 1913.]

	January.	February.	March.	April.	May.	June.
1912.						
	$23.75	$24.25	$25.00	$26.00	$29.50	$29.50
	16.25	16.25	16.00	15.75	17.75	23.50
1913.						
	20.50	20.50	20.50	21.75	21.50	20.50
	14.25	14.25	12.75	12.75	14.25	13.75
1914.						
	21.00	20.00	20.75	20.75	21.25	21.50
	16.25	16.25	15.75	14.75	15.75	16.25
1915.						
	21.50	21.25	22.25	22.75	23.50	24.00
	20.50	20.00	19.75	19.25	20.75	21.50

	July.	August.	September.	October.	November.	December.
1912.						
	$27.00	$25.25	$23.25	$22.25	$22.50	$22.25
	20.50	18.25	16.25	15.75	14.75	14.75
1913.						
	20.50	21.50	21.25	21.00	21.00	20.75
	12.75	13.75	13.75	14.75	15.25	16.25
1914.						
	20.75	23.25	21.25	21.25	21.50	21.25
	17.00	17.25	19.50	19.00	20.50	20.25
1915.						
	25.25	27.50	.....	.....	.....	.....
	21.75	22.75	.....	.....	.....	.....

rices on or about the 16th of each month. Compiled from the Hay Trade Journal.

mparing the prices of hay in any two markets an exact and
ratio according to freight rates or import duties is not to
cted, by reason of the character of the hay trade, the tem-
influence of local conditions, and of spot stocks and demand.
r, the price data given above clearly indicate the price rela-
between the markets. Prior to October, 1913, Montreal
were lower than those in Boston by an amount roughly ap-
ating freight charges (about $3.60 per short ton) plus duty
nor charges (about $4 per short ton); but when the import
as lowered the Boston prices remained substantially on the
vel, while the Montreal prices rose. Reference has already
ade to the fact that although the Canadian crop of 1913 was
ort, exports to the States continued. No attempt has been
o chart prices subsequent to July, 1914, because of the uncer-
ments introduced by the war, which for a time made the

Canadian prices rise above the American level. The Canadian surplus under the conditions obtaining from 1913 to 1918 was not of sufficient volume to affect American prices to any material extent, and the lowering of the American import duty raised the whole level of prices across the border both for producers and consumers.

Comparative producers' prices.—The foregoing conclusions are confirmed by such data regarding producers' prices as are available. The prices given in Table 11 are averages for large areas, some parts of which may have dissimilar market and price conditions, but on the whole they are broadly representative.

TABLE 11.—*Average producers' prices per ton of hay, New York State and Quebec Province, 1910–1916.*

[Figures for New York are from estimates of farm prices and crop values, by States, issued by the U. S. Department of Agriculture. Quebec prices are from similar estimates appearing in the "Monthly Bulletin of Agricultural Statistics," issued by the Department of Trade and Commerce. The farm prices selected as being representative for the crop year by these agencies are those of Dec. 1, on which date prices are considered to be the average of the range of values for the harvests of the same year.]

Year.	New York State.	Quebec Province.	Difference in favor of New York.
1910	$13.70	$9.29	$4.41
1911	17.90	10.17	7.73
1912			
1913			
1914			
1915			
1916			

During 1910, 1911, and 1912 the
State were higher than the prices in
$7.73, and $5.54, respectively; in 19
the advantage of New York was les
during 1914, 1915, and 1916 were d
Canada and the United States ex
ceived by producers in Quebec wer
the border.

○

UNITED STATES TARIFF COMMISSION
WASHINGTON

Tariff Information Series No. 21

INDUSTRIAL READJUSTMENTS

OF

CERTAIN MINERAL INDUSTRIES

AFFECTED BY THE WAR

Antimony	Potash
Chromite	Pyrites
Graphite	Sulphur
Magnesite	Quicksilver
Manganese	Tungsten

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PREFACE.

This volume deals with certain minerals and metals [1] which experienced substantial industrial expansion in the United States during the European war. They are considered in the following order:

Antimony.	Magnesite.	Pyrites and Sulphur.
Chromite.	Manganese.	Quicksilver.
Graphite.	Potash.	Tungsten.

Antimony, a metal entering many lines of industry in times of peace as an alloy with lead and tin, and of military importance as a hardening constituent of shrapnel bullets, is obtained mainly from Chinese ores. China has the great high-grade antimony deposits of the world. The ore is also available from Bolivia, Mexico, France, and Spain; the known ore resources of the United States are slender.

Chromite, the ore from which are obtained the chromium required by the steel industry and the chromium salts used in the chemical and paint industries, was imported from New Caledonia, Rhodesia, and Asia Minor prior to the war. The requirements of the United States—some 50,000 tons—were obtained almost entirely from these countries. The domestic industry suddenly expanded during the war to a capacity sufficient for this need.

Graphite, a mineral of wide industrial utility, but principally important as material for the manufacture of crucibles used in the melting of various major metals, before the war was mainly supplied in special grades from Ceylon and Madagascar.

Magnesite, essential for the refractory linings of furnaces in the steel industry, and increasingly used as a plastic material for walls and floors, formerly supplied by importation from Austria and Greece, was obtained during the war from domestic operations.

Manganese, a metal essential in the production of certain qualities of steel, was imported to the extent of 300,000 tons a year—practically the country's total requirement—before the war. Domestic production during the war increased with great rapidity from 3,000 to 300,000 tons annually, but the domestic deposits are low grade and scattered, and the industry is powerless to compete with the great natural deposits of Russia, India, and Brazil.

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[1] A survey of barytes, a mineral used in the paint, rubber, linoleum, and chemical industries, is omitted from this volume. The Commission is publishing a report on that mineral under the title, "The Barytes, Barium Chemical and Lithopone Industries, including Costs of Production, 1919."

Potash, necessary as a fertilizing element in the agricultural industries, has for many years been obtained from Germany, which possesses the world's richest deposits. The United States has developed during the war at a very high cost a productive capacity sufficient for almost one-half the domestic needs.

Pyrites and sulphur are mainly important as raw materials for the manufacture of sulphuric acid, essential in various industries and, in war time, in the manufacture of high explosives. Sulphur is also largely used in the paper-pulp industry. Ample domestic resources exist, and the domestic competition between sulphur and pyrites for the sulphuric-acid market is more important than the competition from abroad. But Spanish pyrites possesses extraordinary competitive strength.

Quicksilver, of military and industrial importance as an essential constituent of all detonators for high explosives and in numerous technical and scientific uses, was obtained during the war from American deposits which are notably low in grade—averaging less than five-tenths per cent metal content. Spanish quicksilver, derived from ores carrying upward of 8 per cent metal, is abundant, and European quicksilver can readily supply the American market at prices far below domestic costs.

Tungsten, a metal of military importance as the hardening element in high-speed tool steel, is now being supplied almost entirely by importation from Asia, after a spectacular war-time expansion and subsequent collapse of the American industry.

In the preparation of this report the Commission had the services of Guy C. Riddell, Paul M. Tyler, and S. L. Willis, of the Metals Division of the Commission's staff, of C. R. De Long and S. D. Kirkpatrick, of the Chemical Division, and of others.

INTRODUCTION.

WAR DISTURBANCES IN THE MINERAL INDUSTRIES.

The disturbances caused by the war in the conditions surrounding the production and use of raw minerals and metals in the United States in some respects were unique. The temporary discontinuance of imports from many foreign sources of supply and the difficulties of transportation from such as remained open forced this country to rely to the utmost on its own resources. Coincidental with this interruption of supply there developed a greatly increased and urgent demand for all metals and minerals that could be used either directly or indirectly for military purposes, and there were few that were not adapted to such use. In the case of some of them the productive capacity of this country enabled American producers to extend the scope of their operations sufficiently to meet the increased demand without materially raising the unit cost of the additional output. But in the case of others, larger supplies could be produced only at costs that far surpassed what had been customary in time of peace. These costs differed widely for different minerals both in nature and in degree. Most often increased costs were caused by the necessity of drawing upon ore bodies of poorer quality and remoter location than could profitably be developed under normal conditions. Sometimes the added costs were due to the installation of expensive equipment that had to be specially designed in order to secure quantity production under unfavorable conditions. In the case of some minerals there had to be much prospecting and experimental work before there was any substantial production. And in some rare instances, our dependence on foreign supplies had been so complete that effective methods of production had to be devised, the labor trained, and the whole industry organized and financed.

Prices quickly responded to the discrepancy between the supply of the minerals and the demand for them. In some cases they rose rapidly until they were several hundred per cent above the prewar level, and were sufficient without other inducement to stimulate production in the desired amount. But these prices were obviously precarious and subject to immediate collapse with the reopening of international commerce, and the production from sparse and low-grade domestic resources of some of the needed minerals required investments of greater magnitude than were justified by purely

economic considerations. The ordinary inducement of profits was therefore at times supplemented by requests from the Government that supplies be produced in quantity sufficient to meet the urgent needs of the Nation in the prosecution of the war.

Widely divergent as were the motives of investors, their combined result was a production of metals and minerals that was astonishing, both in variety and in amount. Not only, however, was this achieved at far greater cost and under greater difficulty in some lines than in others, but also some industries were more severely affected than others by the cessation of hostilities. Among the many industries involved, some were already so firmly established and so highly developed before the war that contraction to accord with a normal demand for their products could be effected without weakening their ability to compete with foreign supplies. Some also received a stimulus during the war that added permanently to their strength, and the renewal of peace conditions finds them better prepared to meet international competition than they have ever been before. There is a third group composed of industries that either can not be maintained at all or, at best, can be maintained only on a greatly reduced scale, if costs remain relatively high and prices recede to the prewar level.

Each industry in all these groups presents conditions and problems peculiar to itself. No one of them is typical in such measure that a study of it can lead, except in part, to conclusions applicable to the others. Only after consideration of the conditions and prospects of a particular industry will a decision be advisedly reached on any policy of Government aid to any one of these industries through the tariff or otherwise.

The industrial surveys included in this volume are similar in form to the material being compiled by the Tariff Commission in its investigation of the entire list of industries and commodities mentioned in the tariff schedules. The surveys here presented are standard units of a tariff information Survey, which is a compilation of industrial data continuously under way for the use of Congress in its consideration of tariff revision. In view of rapidly changing industrial conditions, these reports are at no time considered complete or final. They are intended, rather, as broad surveys of the situation reflecting without argument the main facts and figures pertinent to tariff legislation. The Commission is constantly seeking and obtaining data and information on current industrial development, and in its many investigations and reports it welcomes frank comment and criticism from those familiar with the subject or qualified to speak with authority on the industries concerned.

As yet the Commission has not made independent investigations of production costs of any of the minerals or metals here discussed.

Both foreign and domestic costs are and will be unstable for a considerable time to come. In the present treatment the main effort has been to present, aside from costs of production, the major factors which determine the competitive position of our domestic industries in world trade.

The statistics used in this publication are the latest revised data obtainable from Government and other reliable sources. Figures in prior publications of the Tariff Commission on the industries discussed in this volume have been corrected, wherever necessary, in accordance with the latest reported changes and revisions.

GENERAL FEATURES OF THE SITUATION.

Without reference for the time being to the permanence of American resources, the United States, as one of the results of the war, has gone a long way toward becoming self-sustaining in the production of many minerals. This has occurred under the stimulus of prices usually several times higher than before the war. While it is now probable that this country, under continued pressure, can meet its requirements from domestic sources, the position of these and some other minerals is a forced one, developed by war demands, artificial import restrictions, and high prices. Whether such production is to be continued at high cost involves weighing, on the one hand, the relative importance to the country of industrial and military self-sufficiency; on the other, the extent to which it is desirable to participate in the most economically advantageous distribution of the world's exportable surplus of these commodities. The following additional considerations likewise deserve attention:

(1) For the first time it is now apparent that the United States has certain mineral resources which can be substituted for the major part of its former imports. Reliance on these domestic resources, however, means (*a*) that the advantage of procuring for domestic industries a high grade of raw materials at a relatively low cost is to be disregarded; (*b*) that the position of foreign competing industries by which these foreign raw materials are used is to be strengthened; and (*c*) that the market enjoyed here by foreign countries possessing such materials is to be lessened.

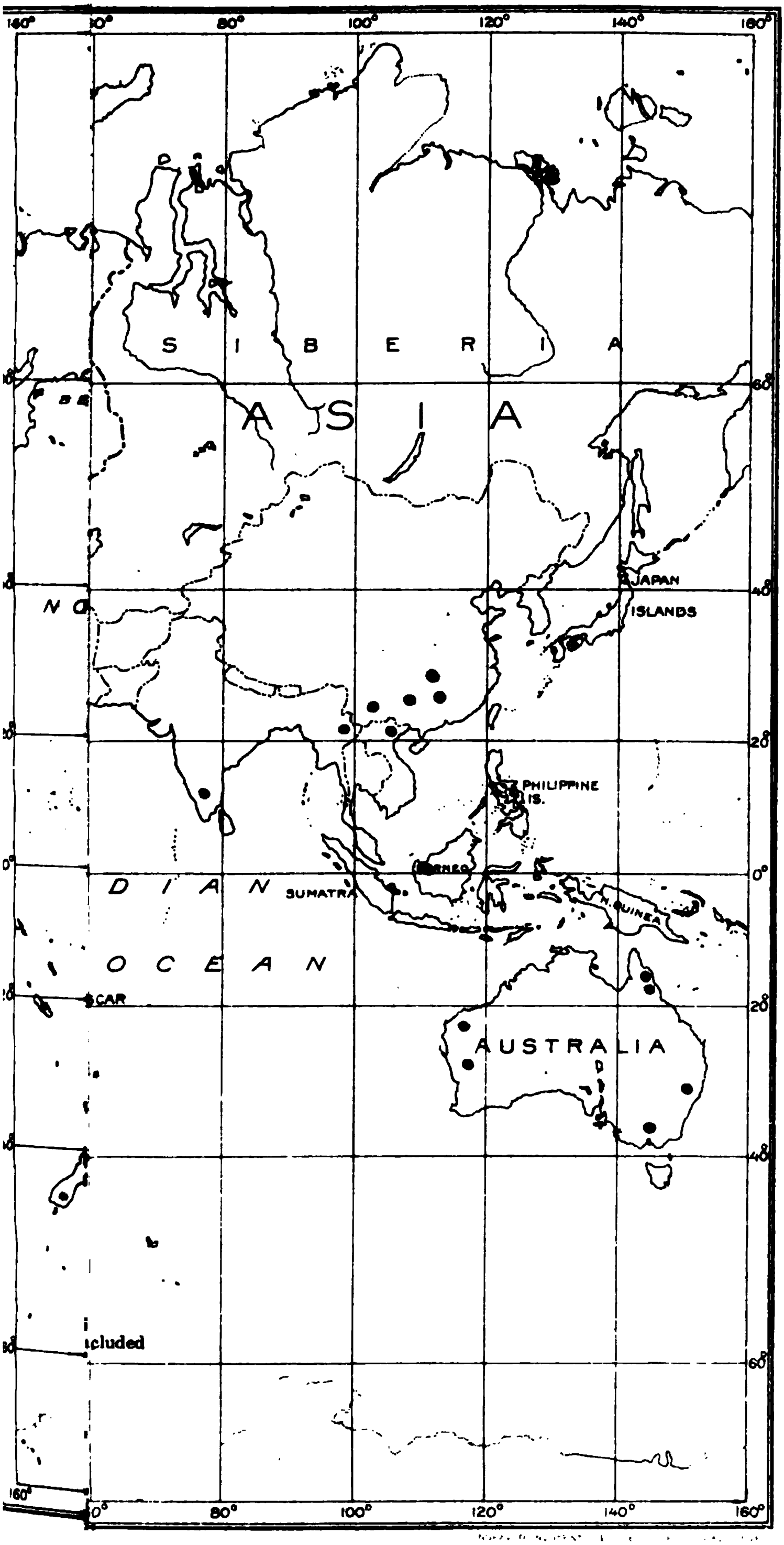
(2) National conservation both of resources and labor must be constantly held in mind. By way of illustration, the manganese, chromite, tungsten, quicksilver, and antimony deposits of the United States are small in quantity and of low grade, in comparison with supplies from foreign sources. Insistence on the use of the domestic materials means not only the certainty of higher costs, but the possible early exhaustion of domestic supplies. In the wisest and fullest utilization of domestic mineral resources, the occasion for utilization must have full measure of attention. A question of economy is raised by

temporary restriction of imports, either by a considerable increase of duties or other means.

(4) The situation in some of these industries is rendered more difficult by the condition of foreign markets. In various parts of the world stocks have accumulated as a result of the shortage in ships and of the slack demand in some countries that are normally heavy buyers. The offering of foreign minerals at low prices in the American market may have much the same effect on domestic industries as is usually attributed to "dumping." Such abnormal competition is temporarily delayed by high ocean freight rates. The delay gives some aid in the process of liquidation and readjustment of industries producing bulky low-priced minerals, such as magnesite, manganese, and chromite, but it affords little help to such high-priced materials as tungsten and quicksilver.

(5) Another influence probably affecting the relative competitive position of American and foreign producers is the present low rate of foreign exchange. Distinctly one-sided trade relations have existed during the last five years between the United States and foreign countries, and the virtual abandonment of the gold standard in various European countries has resulted in the depreciation of their currencies. The competitive strength of European commodities is subject to whatever uncertainties attend the present exchange rates on the krone, mark, franc, lire, and other units of currency.

ANTIMONY



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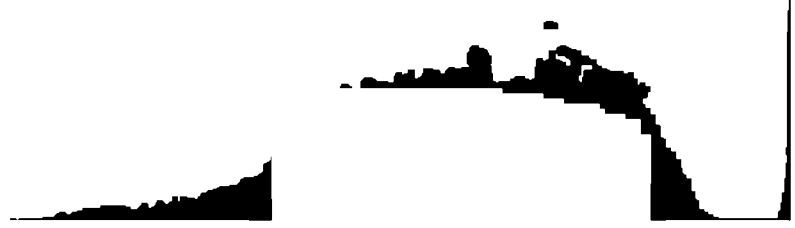

ANTIMONY.

SUMMARY.

IPORTANCE OF THE INDUSTRY.

Antimony is an essential war metal, since it is a necessary constituent of shrapnel, in addition to its many industrial and other as important munition uses. The tonnage involved, however, is latively small, and it was the policy of the War Industries and ipping Boards during the war period to depend on the natural ovement from China for the 12,000 to 18,000 tons annually required the United States.

Antimony goes into the manufacture of type metal, nearly all aring metals, and white-metal alloys. Small amounts of antimony e requisite to the production of hard lead. This material is largely ed in chemical plants and is necessary in the manufacture and for ie handling of sulphuric acid.

OMESTIC AND FOREIGN RESOURCES.

Domestic deposits of antimony are of both high and low grade, ut are widely scattered and of doubtful importance. Previous to ie sudden stimulation in 1915–16, antimony mining was of meager roportions in the United States. Some half dozen mines maintained perations into 1918, but they contributed less than 2 per cent of the omestic requirements. China has large, easily mined, and rich eposits, which, with cheap labor, make that country foremost among ources of the world supply. Deposits in other countries, notably lexico, Canada, and Bolivia, are much superior to those of the United tates, but China can furnish the antimony supply of the world at osts that are relatively extremely low. It is especially unlikely that merican mines could furnish any large supply except at extravagant ost.

OMESTIC SUPPLIES.

The bulk of the antimony used in the United States is imported n the form of refined metal (regulus) from Chinese ore smelted either n China or Japan. During the war period a smelting industry was tarted in the United States, although it was forced to rely chiefly n foreign sources for its ore supply. A third and important factor n the supply is the steady production of antimonial lead, a by-roduct of the smelting and refining of both domestic and foreign ead ores. The combined capacity for producing domestic metal is bout one-half the normal domestic consumption.

Future Competitive Conditions.

Under normal conditions, there is no possibility of the survival of domestic antimony mining, at least from the present known deposits. It is doubtful, even if the ore is continued on the free list, whether, with present duties on the metal, domestic smelters can continue operations. It is possible that American smelters can eventually bring their costs as low as, or lower than, the Chinese or Japanese through greater effectiveness of labor and better management, but the advantage of the cheaper ore supply of the foreign smelters is very considerable. Practically no antimony was smelted in this country before the war, and the position of foreign smelters was strengthened far more than that of the domestic producers during the war period.

THE ANTIMONY INDUSTRY.

Tariff act of 1913, paragraph 144:

Antimony, as regulus or metal, and matte containing antimony but not containing more than 10 per centum of lead, 10 per centum ad valorem; antimony oxide, salts and compounds of, 25 per centum ad valorem.

Tariff act of 1913, paragraph 396:

Antimony ore and stibnite containing antimony, but only as to the antimony content, free.

DESCRIPTION AND GRADES.

Metallic antimony unalloyed has few industrial uses. It is a brittle metal, of silvery luster, easily powdered, of rather low melting point (630° C.), and of specific gravity about 6.5. Antimony alloys readily with most heavy metals, the alloy being harder than the two pure metals, and in most cases possessing the property of prompt expansion on solidifying, which enables very sharp impressions to be obtained in casting. Type metal, bearing metals, Britannia metal, and hard metal (antimonial lead) are the commodities making up the largest consumption of antimony.

The chief marketable products are (1) antimony crude, antimony "needle" or antimony sulphide, and (2) antimony regulus. The former is produced by submitting the ores of the natural sulphide (stibnite) to a red heat. At this temperature the valuable mineral melts, but does not decompose. The operation amounts to liquation or pyro-concentration, whereby the antimony sulphide is separated from barren constituents of the ore. The melted sulphide is run into molds and is commonly sold in lumps of irregular size. The name "needle" is derived from the needlelike structure developed as the product cools slowly in the molds. The Department of Commerce classifies this material as "matte." It contains 71.4 per cent antimony.

Regulus is the term commonly used to describe antimony metal. Antimony metal is not marketable unless it is at least 99 per cent pure. It is cast in ingots of regular size. It has long been the practice of the trade to judge the purity of antimony by the development of the fernlike appearance or "star" on the surface of the ingot. This starring is nothing more than an artificial decoration produced by allowing the molten antimony to cool slowly under a layer of slag containing a starring mixture. The starring operation adds an unnecessary cost of from $5 to $30 per ton, and is not entirely reliable as an index of grade.

Both sulphide and regulus are usually packed in cases of 224 pounds net weight (i. e., 10 cases to the long ton).

Impure products of the English direct process known as "single" and "double" metal containing about 90 and 98 per cent antimony, respectively, have been factors in the English import trade, but have never entered the United States in any quantity

Some users of antimony are not particular in regard to the purity of the metal, but certain qualities are demanded, viz, (1) uniform grade; (2) freedom from sulphur and arsenic, and (3) little dross when remelted with other metals. These are the qualities that give preference to certain brands. It is a decided advantage to be able to measure out a definite proportion of the metal when alloying with other metals and to allow the melt to stand for a long time without too frequent skimming of dross.

ORES OF ANTIMONY.

The chief commercial ores of antimony are: (1) Stibnite, Sb_2S_3, gray antimony ore, or antimony glance; (2) valentinite, Sb_2O_3, or antimony oxide; (3) cervantite, Sb_2O_4, or antimony ochre; (4) jamesonite (2 PbS, Sb_2S_3), containing about 30 per cent antimony and 51 per cent lead.

Stibnite is the ore mineral in all large deposits. Valentinite and cervantite occur occasionally on the surface, but change to stibnite at depth. Jamesonite is present in the antimonial lead ores of the Rocky Mountain region and is the principal mineral in the Mexican deposits. It is second to stibnite as a source of antimony.

SOURCES OF SUPPLY.

The United States is dependent upon three classes of material as sources of antimony. These are:

1. Antimony ore, imported from China (direct or via Japan), Bolivia (via Chile and Peru), and Mexico. Small amounts of ore are also produced in the western United States.

2. Liquated antimony sulphide ("crude" or "needle antimony") imported in small amounts from China (in part via Japan); antimony content, 65 to 71.4 per cent.

3. Metallic antimony or antimony regulus, the antimony of commerce. This is imported from China (direct or via Japan), but is also produced in small amounts in the United States, from both foreign and domestic ores.

A class of material which should also be mentioned in this connection is antimonial lead, of domestic origin, carrying from 12 to 18 per cent antimony. Into this product enter all three classes of material noted above, and also lead ores of the antimony variety.

USES.

Antimony is a highly important war metal, being used especially in shrapnel, for bullets, in primers, and to produce a white smoke for range finding. Apart from its use as an agent of destruction, the use of antimony, while varied, is comparatively limited. Owing to its very brittle character, pure antimony can not be used alone for industrial purposes. Its chief application is in alloys, especially type metal, Britannia metal, babbitt and other bearing metals in which it is used as a hardening agent. The alloys with lead and tin are by far the most important. Antimony compounds are used in medicine. The well-known tartar emetic and antimony fluoride are employed as mordants in the dyeing of cloth. The sulphide is an important ingredient in safety matches. The precipitated sulphides of antimony are used as colored pigments in the paint trade, and the pure sublimed oxide is a common ingredient in enamels for coating metal ware. Patents have recently been issued on new antimony chemical products that will considerably extend the industrial usefulness of the metal. These products will go into the building trades.

War uses.—Shrapnel lead is a mixture of lead and antimony (12 to 25 per cent antimony), which is most extensively used in the production of shrapnel bullets. The presence of the antimony hardens the lead. Small quantities of liquated antimony sulphides are used in the primers of shells. Antimony sulphide as a powder is used in the charge of some shells to produce on explosion a dense white smoke, which is of service in range finding.

SUBSTITUTES.

It is possible to harden lead by the use of small quantities of substances other than antimony, notably calcium, barium, strontium, magnesium, and copper. In the last year or two, the alloy with calcium and barium has come on the market, and threatens to be a rival of antimony in the bearing metal field. In any event, it is a possible substitute, especially as it also serves to conserve tin, another ingredient of most antifriction alloys. There are a host of substitutes for antimony pigments, many of them on a stronger competitive footing than the antimony compounds. Tin oxide makes a better enamel than antimony oxide—in that it is pure white, whereas the antimony enamels have a yellow color. The use in coffin handles and for similar purposes which consume and destroy a surprising amount of this metal can be done away with. Both aluminum and zinc are often substituted. In general, however, antimony may be considered as a cheap metal that will become a substitute for expensive metals rather than be itself replaced.

Domestic production, imports, and exports of antimony.

ANTIMONY ORE.

Calendar year.	Domestic production.[1]	Imports for consumption,[2] Sb content.	Exports of foreign antimony ore from United States.[2 3]	Ratio to production.	
				Imports.	Exports.
	Pounds.	*Pounds.*	*Pounds.*	*Per cent.*	*Per cent.*
1910	.....	[4] 1,346,962	.....	.....	.....
1911	.....	[4] 1,641,467	.....	.....	.....
1912	.....	[4] 1,562,066	.....	.....	.....
1913	.....	[4] 4,014,846	.....	.....	.....
1914	.....	2,508,629	.....	.....	.....
1915	[5 6] 4,200,000	3,088,541	195	73.5	.....
1916	[5 6] 3,540,000	9,243,005	255,695	261.1	7.23
1917	[5] 517,013	11,663,165	.....	2,255.9	.....
1918	[5] 254,000	2,849,728	.....	1,121.9	.....
1919	.....	818,401	5,390	.....	.....

	Value [2] (imports for consumption).	Amount of duty.[2]	Value per unit of quantity.[2]	Equivalent ad valorem rate (per cent).
1910 [4]	$47,185	$13,469.62	$0.035	28.6
1911 [4]	60,459	16,414.67	.037	27.2
1912 [4]	51,444	15,620.66	.033	30.4
1913 [4]	137,361	15,120.09	.034	[7] 28.7
1914	71,341	.....	.028	.....
1915	832,125	.....	.107	.....
1916	1,072,340	.....	.116	.....
1917	1,006,884	.....	.086	.....
1918	177,731	.....	.062	.....
1919	54,477	.....	.067	.....

[1] From United States Geological Survey.
[2] From Department of Commerce, Foreign Commerce and Navigation.
[3] No domestic exports.
[4] Includes "matte."
[5] Antimony metal from domestic ore.
[6] Estimated.
[7] Based on imports from Jan. 1 to Oct. 3, 1913, valued at $52,767 which were dutiable.

ANTIMONY, MATTE, REGULUS OR METAL.

Calendar year.	Domestic production.	Imports for consumption.	Exports of foreign antimony metal from United States.[2 3]	Ratio to production.	
				Imports.	Exports.
	Pounds.	*Pounds.*	*Pounds.*	*Per cent.*	*Per cent.*
1910	[8] 4,458,000	7,955,945	[9] 339,685	178.0	.....
1911	[8] 4,508,000	8,486,135	[9] 160,844	188.0	.....
1912	[8] 3,898,000	13,936,873	[9] 50,684	358.0	.....
1913	[8] 5,016,000	12,479,727	[9] 63,980	249.0	.....
1914	[8] 5,386,000	13,110,426	1,600,979	243.0	.....
1915	[8] 11,050,000	14,708,002	3,146,135	133.0	.....
1916	[8] 10,532,000	14,127,289	3,018,251	134.0	.....
1917	[8] 6,034,000	22,571,377	989,477	374.0	.....
1918	[8] 5,386,000	28,022,934	1,410,970	520.0	.....
1919	.....	14,875,211	428,059	.....	.....

	Value (imports for consumption).	Amount of duty.	Value per unit of quantity.	Equivalent ad valorem rate (per cent).
1910	$492,570	$119,339.17	$0.062	24.2
1911	470,552	127,292.06	.055	27.1
1912	808,473	209,053.11	.058	25.9
1913	798,581	142,046.47	.064	17.8
1914	736,420	73,642.00	.056	10.0
1915	2,660,830	266,083.00	.181	10.0
1916	3,548,507	354,850.70	.251	10.0
1917	2,829,159	282,915.90	.125	10.0
1918	3,065,619	306,561.90	.109	10.0
1919	1,040,789	104,078.90	.070	10.0

[8] Includes antimony metal contained in antimonial lead produced by domestic smelters; does not include metal from foreign ores.
[9] Includes ore and matte.

DOMESTIC PRODUCTION.

Quantity.—In 1917 the production of antimony metal in the United States was 517,013 pounds from domestic ores and 4,363,406 pounds from foreign, a total of 4,880,419 pounds. In addition to the domestic production of antimony, the antimonial lead produced as a by-product by lead smelters should be considered as a domestic supply. The antimony content of this material in 1917 was 5,518,000 pounds, or a little more than the annual production for the years just preceding the war. While this antimony comes partly from foreign ore, it is a staple product, the ore being imported chiefly for its lead contents. The total domestic smelter production, therefore, in 1917 was equivalent to over 10,398,000 pounds of antimony. The total production was 10,366,000 in 1918 but the figures for 1919 will show a marked falling off from the 1918 output.

History.—The history of antimony smelting in the United States is brief, dating only from 1915. Antimonial lead, of course, has been produced by lead smelters since the development of argentiferous lead ores (which almost invariably contain a little antimony) in the seventies, but the business of smelting with the sole object of producing antimony is an outgrowth of the war.

Methods and processes.—There are four commercial smelting processes for recovering antimony metal from its ores:

(1) Rich ores or liquated sulphide are dead-roasted in hearth or reverberatory furnaces and the roasted ore is melted with soda ash and carbon, in a small reverberatory furnace, to obtain the metal.

(2) Rich ores may first be heated with little or no air. A large part of the sulphide present melts and runs to the bottom of the furnace and is tapped off. This product is the liquated sulphide mentioned above. The residue from this treatment, together with lean ores, is mixed with coal and charged into a shaft furnace (Herrenschmidt furnace). The remaining antimony is here driven off and deposits in the settling chambers and flues as an impure oxide. This can be treated with roasted rich ore in the metal furnace.

(3) Blast furnace smelting of antimony ores has been developed commercially in the United States.

(4) The English direct smelting process, used also to some extent in China during the war, eliminates the roasting expense. Rich ores only are used and large amounts of scrap iron are used to take care of the sulphur. The product of the first melt, known as single metal, is melted with a small amount of crude to remove any iron remaining in the metal and then cast for the market. It is possible to smelt lean ores this way, but the cost of fluxes is prohibitive.

Equipment.—The amount of equipment necessary for antimony smelting is small compared with that required for most metal-

lurgical processes. The furnaces are simple, and on account of the minor scale of the operations no extensive preparations are required for the economical handling of materials.

Raw materials.—On account of the methods of smelting and the generally high purity of antimony concentrates, the fuel and flux requirements are moderate.

Localities.—In ordinary times the United States has been considered devoid of antimony ore that could be worked at a profit. The activity of 1916 resulted in mushroom productions from various States. These were, in order of importance in the 1916 output, California, Nevada, Alaska, Washington, Idaho, and Arkansas. Utah and Arizona were small producers, and prospects were developed in Montana and other States. Very few of these new enterprises operated after the price decline. The 1919 domestic production was negligible.

There are only four or five smelting plants in the United States that operate on antimony ores alone. These were all started in 1915–16. The Chapmen Smelting Co., of San Francisco, opened up an abandoned plant which was closed again in 1917, after treating ores from Nevada, Alaska, Canada, and elsewhere. The Antimony Smelting & Refining Co. built a plant at Seattle and manufactured oxide for a time from Washington ores. The Western Metals Co. built an antimony smeltery at Los Angeles, which now smelts largely Chinese ores, but has drawn a part of its supply from Colorado, Nevada, and Mexico as well as ores from its own mines in California. The Magnolia Metal Co. has a plant at Matawan, N. J., purchasing ore from various sources. The Nichols-Layng Chemical Co. operated a plant at San Francisco. The Antimony & Compounds Co., at Piscataway, N. J., is another operator. These plants are in intermittent operation only; in 1919 the Magnolia Metals Co. went out of business, and the American Star Antimony Co., of Arkansas, offered its mining properties and works at public auction. The demand for antimony in the various forms is strong, but the foreign material—mined, smelted, and refined in China—can be sold in the United States at a price considerably less than one-half that at which American antimony can be produced.

Besides the above-mentioned companies antimony ores were smelted for the production of antimonial lead by the International Lead Refining Co., East Chicago, Ind.; the Great Western Smelting & Refining Co., Chicago; and the American Smelting & Refining Co., Murray, Utah.

Organization and capitalization.—The antimony mining enterprises, almost without exception, were started by prospectors and others with little capital; but at least two of the large consumers also engaged in the search for domestic supplies. The manufacturers of antimony are well established and strong financially. Antimony is

not their finished product; in fact, it is rather less than half of the metal content of bearing metals, etc., produced.

In 1919 there were practically no antimony mines working. The manufacturers were operating on foreign ore or metal.

Consumption and production.—The prewar consumption of antimony in the United States was moderate, averaging only a little more than 7,000 tons annually, although, just before the war, it increased about 25 per cent. Antimonial lead furnished from 2,000 to 2,500 tons. The remainder was derived from imports—almost exclusively in the form of regulus or refined antimony metal. During the war the demand increased to more than 1,500 tons per month for domestic consumption and nearly 600 tons a month for exports. The exports were largely in the form of manufactures (munitions) with benefit of drawback.

The following table shows the estimated consumption of antimony in the United States from 1910 to 1918, inclusive:

Antimony content of ore, matte, regulus, and metal (1910–1918).[1]

Calendar year.	Domestic production.		General imports.[2]		Exports.[2]		Domestic consumption.[5]
	Antimonial lead.[3]	Antimony ore, Sb content.	Ore, Sb content.	Matte, regulus, or metal.	Of foreign merchandise.	With benefit of drawback.[4]	
1910	2,229	.....	(6)	[7] 4,950	170	23	6,986
1911	2,254	.....	(6)	[7] 5,479	80	37	7,616
1912	1,949	.....	(6)	[7] 8,823	25	41	10,706
1913	2,508	.....	(6)	[7] 7,691	32	34	10,133
1914	[8] 2,705	.....	993	6,535	800	33	9,400
1915	3,425	[9] 2,100	1,687	8,742	1,573	14	14,367
1916	3,496	[9] 1,770	4,743	9,875	1,637	716	17,531
1917	2,759	[10] 390	5,960	17,825	495	6,293	20,146
1918	2,566	[9] 50	1,359	13,874	705	1,178	15,966

[1] In short tons. Antimony produced from secondary sources not shown.
[2] Data from Commerce and Navigation, Department of Commerce. Domestic exports nil.
[3] From foreign and domestic ores. Data from United States Geological Survey.
[4] Fiscal year. Quantities calculated from values. Calendar year figures unobtainable.
[5] Obtained by deducting exports (domestic, foreign, and under drawback) from domestic production plus general imports.
[6] Included with matte, regulus, or metal prior to Oct. 4, 1913.
[7] Includes ore.
[8] Includes a few tons antimony produced in electrolytic refining of copper.
[9] Antimony contents of domestic antimony ore. Some of this ore entered into the Antimonial lead, as shown in first column.
[10] Smelter production, 517,013 pounds in 1917 and 254,000 in 1918. (1917 first year in which recorded.)

This table has been prepared from the most recent and authoritative data. There is an element of error in using the statistics for exports with benefit of drawback, as these are obtainable only for fiscal years, whereas the other statistics are for calendar years. Except for the abnormal years of 1916–17, however, these exports were negligible in amount. The actual amount of antimony recovered in the smelting of the foreign ore is known only for 1917 and 1918 and does not appear in the table. The figures of consumption are a trifle higher than the actual, since about 20 per cent of the metal contents of the ore is lost in smelting.

The postwar consumption is likely to be higher than the prewar level and will probably amount to 10,000 or 12,000 tons annually. Even assuming that the existing smelteries operate, the domestic production of antimony, including that in antimonial lead (which amounted to a little over 4,600 tons total in 1917), would furnish only from 30 to 50 per cent of the supply, and this would be in large part from imported ore.

Exports.—No appreciable amount of domestic antimony has ever been exported from the United States. Foreign exports go mainly to Canada, although trifling amounts are shipped to all parts of the world. These exports decreased in 1917 to less than one-third those of 1916 because of the plan adopted by the Canadian Government of importing its supplies from the primary market (China or Japan) rather than from New York. The exports with benefit of drawback in 1917 consisted almost exclusively of shrapnel with only a small amount of bearing metals.

FOREIGN PRODUCTION.

The total world production of antimony during the three years prior to the war averaged about 30,000 tons. Approximately 70 per cent of this quantity was supplied by China in the form of antimony metal, needle or crude, and ore. The ore went mostly to England, Japan, and Belgium.

China.—For many years China has been the leading producer of antimony ore and the mining and smelting of antimony has been one of the large and active industries of that country. The antimony-bearing area is estimated as over 700,000 acres. Over 175 mines are operated. A great many of these are owned by small operators, but the leading factor in the industry is the Wah Chang Mining & Smelting Co., a corporation with branches in the United States and other consuming countries. This one company exported over 14,000,000 pounds of metal during 1917. The Wah Chang Co. operates its own mines, smelteries, and sales agencies. Its smeltery at Changsha is the largest antimony works in the world. There are several independent smelteries at Hankow and new works erected at San Shui in South China take ore from independent producers. Much Chinese ore is also exported.

Before the war China supplied approximately 70 per cent of the world supply of antimony and during the late war period furnished about 60 per cent. In 1917 China exported 16,800 short tons of regulus, 22,400 tons of crude, and 4,480 tons of ore. The bulk of the regulus came to the United States either direct or through Japan. Of the crude and ore fully 75 per cent was shipped to Japan for smelting, the refined metal being sent to the United States, Canada, and Russia. Japanese shipping plays an important part in the marketing of Chinese ore.

Japan.—At one time Japan produced a notable tonnage of ore, but its domestic supplies are not large. It is still an active factor in the industry because of its large smelting business, operated largely on Chinese ores.

South America.—The largest known resources of antimony ore outside of China are in Bolivia, but mining is handicapped by the necessity of shipping all the ore out of the country on account of the high cost of fuel. Between 1911 and 1914 the Bolivian output never exceeded 320 tons per annum, but in 1915 it reached 18,000 tons, most of which was sent to Great Britain. The following year 27,414 tons were produced, of which more than 21,000 tons went to Great Britain, and the remainder chiefly to France. Toward the latter part of 1918, English smelters were out of the market, their restricted requirements being met by Spanish ore. The Bolivian industry, which has revived slightly, supplies some 5,000 or 6,000 tons annually to British smelters. A little ore is mined in Chile and some in Argentina.[1]

Europe.—Prior to the war France was the second largest producer. Stibnite is found in large deposits in Mayenne, where it contains about 1 ounce gold per ton. Austria-Hungary at one time produced notable quantities of antimony. The history of the industry in Bohemia goes back to the fourteenth century. Recent production, at least before the war, was irregular. Portugal was also one of the foremost producers at one time, but has also shown a declining production in recent years. Spain, on the contrary, has come to the front and supplied England with large amounts of ore during the war.

Italy was an important European producer of antimony metal during the war. The output was greatly increased as a result of high prices and the entrance of Italy into the World War. Reports as to actual production are conflicting, but according to Mineral Resources, 1918, the 1916 production was 1,080 metric tons, compared with 720 metric tons in the previous year. The output comes from old mines in Sardinia and Tuscany and is largely smelted at the mines.

Some antimony is also mined in Great Britain, Serbia, Sweden, and Russia. Grecian ore has also been offered recently.

Africa.—There are important antimony deposits in the Transvaal, at several of which operations were underway in 1916. Occurrences in Rhodesia have been reported but there has been little investigation of these deposits. The most important African mines are in Algeria. These have come forward rapidly in the last few years. The ore is smelted in France. Labor is cheap and plentiful in this region and it is probable that the industry can develop even under normal conditions and prices.

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[1] It is possible that this is Bolivian ore, shipped through Chile and Argentina.

Mexico.—Large deposits of jamesonite exist in Mexico, but have not been worked on account of the unsettled political conditions of the country. Prior to the series of revolutions that began in 1911, English interests were active. The product was shipped to Great Britain before the war, but most of the present Mexican output now comes to the United States. An important Cookson[2] smeltery located at Wadley, 100 miles north of San Luis Potosi, formerly exported "single" metal to England for refining. A new plant, owned by American capital and having a reported capacity of 3,000 tons of metal per year, was completed in 1915 in the city of San Luis Potosi. The comparative quiet in Mexico in 1917–18 was favorable to antimony production. It is believed that Mexico is in a position to compete with China to a limited extent.

Canada.—The Canadian deposits of antimony are small. One of the largest developments is in Nova Scotia. The production, about 110 tons of concentrate a month, is shipped to England for smelting. Canada is a large consumer of antimony, but, like the United States, must rely largely on foreign supplies.

Australia.—Over 2,000 tons of ore were annually shipped to England for smelting before the war. The refined product came in large part to the United States. The Australian deposits are large and carry some 2 ounces gold per ton.

Burma.—Some confidence has been expressed in the development of extensive ore supplies in Burma. Sporadic shipments amounting to several thousand tons of this ore have been made to England; the industry, however, is not well established and has been carried on only by natives.

Production of antimony metal in principal foreign countries.

(In short tons.)

[From Mineral Industry, 1918.]

Country.	1910	1911	1912	1913	1914	1915	1916	1917
Austria			14					
China[1]	7,323	7,701	14,915	14,365	21,655	25,747	27,257	42,482
France	5,115	5,264	5,959	7,044			[1] 4,191	[1] 1,907
Hungary[2]	862	983	947	1,144				
Italy				84	152	604	728	536
Japan	132	107	88	23	4,260	9,201	13,666	7,244
Total	13,432	14,055	21,923	22,660	26,067	35,552	45,842	52,169

[1] Exports of regulus and refined metal. [2] Regulus.

France and England before the war were the only other important smelting countries, although a small amount was produced in Austria-Hungary. There are seven firms in England that smelt and refine ore and crude metal. The antimony contents of ore and metal imports into the United Kingdom averaged, before the war, about

[3] A large English antimony producer.

6,000 tons annually, of which about two-thirds was exported as refined regulus. France and Germany consumed the bulk of the world's supply of antimony in the manufacture of various finished products.

Previous to the development of the Wah Chang Co., Cookson (England) was the leading factor in the world market. This company formed a combination with the Chinese and French producers in 1911, but the association was eventually dissolved.

FOREIGN AND DOMESTIC COSTS.

The Tariff Commission has as yet made no independent investigation of costs of antimony production.

The matter of oriental costs is one always difficult to determine.

Several figures have been published in the technical press. Detailed reports of costs at two Chinese plants follow:[3]

PAO TAI MINING & SMELTING CO. (1911).

Cost of materials and labor.

General labor, per shift of 12 hours	$0.233
Furnace men, per shift of 12 hours	.25
Coal, per ton	11.20
Firewood, per 100 pounds	.30
Charcoal, per 100 pounds	1.00
Soda, per 100 pounds	4.00

Cost of smelting per ton of regulus.

		From crude.	From Hongkong ore of about 34 per cent extract
Crushing crude ore		$2.52	$4.68
Crushing the oxide		.39	.52
General labor		.31	.14
Labor for roasting furnace		5.87	4.23
Coal for roasting furnace		11.45	10.05
Labor for reduction furnace		1.83	3.42
Firewood for reduction furnace		13.47	26.69
Coal for reduction furnace		.60	1.30
Labor for mixing charges		.36	.54
Coal in charges		2.26	3.24
Soda in charges		7.85	17.86
Other miscellaneous labor		.....	.20
Couverture		6.53	10.05
		53.44	82.88
Add:			
Cleaning and boxing	$5.95		
Iron ware	1.64		
Repair to furnaces	1.80	9.39	9.39
Total		62.83	92.27

[3] Tr: A. I. M. & M. E., April, 1918.

LOONG KEE SMELTING WORKS (1915).

Cost of materials and labor.

Coal, per pound	$0.0046
Charcoal, per pound	.017
Soda, per pound	.03
Coke, per pound	.007
Tinned scrap iron, per pound	.013
Antimony trioxide, per pound	.25
Labor, per shift of 12 hours	.40

Cost of smelting per ton of regulus.

		Liquation residue by volatilization process.	Direct smelting of crude.	Natural oxide, about 33 per cent extract.	Natural oxide, about 14 per cent extract.	Direct smelting of rich sulphide ore, 40 per cent extract.
Volatilization process:						
Power plant		$17.70				
Furnace men		15.00				
Labor for spalling and mixing charges		7.06				
Miscellaneous labor for carrying charges and discharging oxide		2.81				
Coke		31.25				
Reduction furnace:						
Soda, charcoal, etc., for charge		17.00	$80.00	$43.00	$139.20	$100.0
Coal for reduction furnace		21.00	25.00	54.00	200.00	45.0
Furnace men		2.60	6.60	8.00	15.00	6.0
Other miscellaneous labor		.15	.20	.50	1.50	.4
Crushing oxide				9.00	21.00	
Boxes, labor for cleaning regulus and for mixing charges for reduction furnace	$8.60					
Couverture	60.00	68.60	68.60	68.60	68.60	68.6
Total		183.17	184.10	183.10	445.30	220.0

These reports show a cost of actual smelting (from crude to regulus) of 3.1 cents per pound in 1911 and over 9 cents per pound in 1915,[4] and the cost of smelting ore containing 33–40 per cent recoverable antimony as 4.2 cents per pound of metal in 1911, and from 9 to 11 cents in 1915. These costs, however, are believed by many to be considerably above the Chinese average and they apply to two of the smaller plants—not to the operations of the dominant producer (the Wah Chang Co.). In any event, there is much scope for further savings in cost by the Chinese smelters. Sweeping changes have been recommended to the antimony producers by Chinese metallurgists, and they promise to be adopted. That cost reductions have actually resulted in the last year or two (assuming the accuracy of the published cost figures) is evinced by the price at which the metal has been selling in the United States. The Chinese producer must pay the following charges on his finished metal before he can lay it down in the New York market:

(1) A national export tax of 5 per cent in addition to various minor interior duties.

[4] One factor is the recent high value of silver exchange on the basis of silver at $1.08 per ounce, or nearly double the average price for the period 1900–1915.

(2) Freight from Shanghai to New York, $17.50 per ton (through rate compared with $22.40 from San Francisco to New York, 1920.)

(3) Duty of 10 per cent ad valorem.

The estimate of the producers at the conference of the United States Tariff Commission at San Francisco in 1918 was a Chinese cost of 10 cents per pound laid down in New York, and this was the estimated cost upon which arguments for protection, were based. However, the difficulty of determining the Chinese costs with accuracy was emphasized.

The total domestic smelting cost including labor, fluxes, freight to market, overhead, etc., but not including cost of the ore, is reported by a large war-time producer to be 6 cents per pound of metal.

IMPORTS.

A large part of the supply of antimony for domestic use has always been imported. A considerable fraction of the importation has been in the form of ore, although up to the suddenly increased demands that appeared in 1915, the proportion of ore to regulus or metal was showing a marked falling off. Thus in 1900[5] out of a total importation of 4,548 tons of antimony 63.4 per cent came in in the form of ore. In 1905 the total importation fell to 3,387 tons of which 30.7 per cent was in ore. In 1910 only 8.7 per cent of the 4,490 tons of antimony imported was in the form of ore. In 1915 the proportion increased to 16.2 per cent of a total importation of 8,035 tons of antimony; of the record importation (1917) of 13,231 tons of antimony, 36.7 per cent was in the form of ore and an additional 0.042 per cent was in "matte," which, prior to the enforcement of the tariff act of 1913, had been classed with ore. There was no importation of this product in 1915.

Antimony imported and entered for consumption, 1913–1918.[a]

Calendar year.	Antimony ore.[b]			Liquated antimony sulphide.[c]		Metallic antimony.[d]		Antimony oxides and other compounds.[e]	
	Quantity.	Antimony content	Value.	Quantity.	Value.	Quantity.	Value.	Quantity.	Value.
	Short tons.	*Short tons.*		*Short tons.*		*Short tons.*		*Short tons.*	
1913	2,860	2,007	$137,361	3	$419	6,240	$796,581	984	$117,169
1914	1,791	1,254	71,341	49	4,004	6,555	736,420	1,372	315,001
1915	2,494	1,544	332,125	.....	.....	7,354	2,669,830	423	132,193
1916	7,840	4,622	1,072,340	.....	.....	7,064	3,548,507	243	109,832
1917	10,083	5,832	1,006,884	796	128,660	11,286	2,829,159	10	5,368
1918	3,363	1,425	177,731	833	113,258	14,011	3,065,619	18	11,904

[a] From Antimony in 1918, U. S. Geological Survey, Mineral Resources.
[b] Classed in Tariff Classification as "antimony ore and stibnite containing antimony."
[c] Classed in Tariff Classification as "antimony matte containing not more than 10 per cent lead."
[d] Classed in Tariff Classification as "antimony, regulus or metal."
[e] Classed in Tariff Classification as "antimony oxide, salts and compounds of."

[5] Unless otherwise noted the references in this section are to fiscal years ending June 30.

The figures in the preceding table show that the bulk of the antimony supply is imported in the form of metal.[a] The growth of the domestic smelting industry is indicated by the greatly increased importation of ore in the last few years. Previous to the war nearly all the antimony supply was imported in the form of metal. Two-thirds of the importation came from Great Britain and the remainder from France, the Orient, and other countries. In 1919 the importation of regulus or metal came almost wholly from China and Japan with a small amount only from Mexico and other countries. About one-third of the domestic antimony requirement, however, is supplied by ores imported from China, Bolivia, and Mexico.

Imports by countries.

[*Fiscal years.*]

ANTIMONY ORE.

Imported from—		1910[c]		1911–1913[b]		1914[c]	
		Quantity.	Value.	Quantity.	Value.	Quantity.	Value.
Chinese Empire	gross tons	.....	.....	.....	.....	541	$23,357
	pounds	55,552	$1,432	.....	.....	848,168	
Germany	gross tons	.....	.....	.....	.....	14	764
	pounds	.....	.....	.....	.....	17,397	
Total	gross tons	.....	.....	.....	.....	555	24,121
	pounds	55,552	1,432	.....	.....	865,565	

		1915		1916		1917	
		Quantity.[d]	Value.	Quantity.[d]	Value.	Quantity.[d]	Value.
Chinese Empire	gross tons	1,496	$82,775	858	$268,477	2,408	$437,999
	pounds	2,100,450		1,359,090		3,555,993	
United Kingdom	gross tons	.....	.....	50	21,899	.....	25
	pounds	.....	.....	78,400		112	
Mexico	gross tons	32	660	1,563	74,141	1,495	64,821
	pounds	[illegible],000		1,301,937		992,664	
Portugal	gross tons	.....	.....	407	115,176	270	27,870
	pounds	.....	.....	632,833		390,282	
Chile	gross tons	.....	.....	3,441	404,857	2,915	461,482
	pounds	.....	.....	4,957,397		4,235,407	
Peru	gross tons	.....	.....	362	38,127	58	5,378
	pounds	.....	.....	537,407		39,067	
All other	gross tons	.....	.....	102	26,092	275	46,350
	pounds	.....	.....	139,048		423,444	
Total	gross tons	1,518	83,435	6,783	948,769	7,421	1,033,885
	pounds	2,122,450		9,006,112		9,636,980	

		1918		1919	
		Quantity.[d]	Value.	Quantity.[d]	Value.
Chinese Empire	gross tons	998	$121,136	100	$5,769
	pounds	1,716,424		57,680	
Mexico	gross tons	1,716	84,433	484	21,797
	pounds	1,553,394		359,589	
Chile	gross tons	1,900	216,791	844	74,165
	pounds	2,529,362		1,271,735	
Peru	gross tons	19	2,180	66	7,345
	pounds	27,226		90,726	
All other	gross tons	647	71,413	4	317
	pounds	699,886		2,391	
Total	gross tons	5,280	495,953	1,496	109,392
	pounds	6,526,292		1,782,121	

[a] Figures for 1910 cover only the period from July 1 to Aug. 5, 1909, inclusive.
[b] Included in "Antimony ore, regulus," etc.
[c] Figures for 1914 cover period from Oct. 3, 1913, to June 30, 1914.
[d] Antimony contents.

[a] In addition to the imports shown in this survey, some antimony is imported in the form of antimonial lead (type metal). These imports were especially important in 1911 and earlier years, but at the present time (1919) do not represent any considerable portion of the antimony supply.

Imports by countries—Continued.

ANTIMONY (ANTIMONY CONTENTS) CHANGED 1911 TO ANTIMONY ORE. REGULUS, OR METAL (ANTIMONY CONTENTS).

Imported from—	1910		1911		1912	
	Pounds.	Value.	Pounds.	Value.	Pounds.	Value.
United Kingdom	4,509,231	$289,273	4,308,906	$260,263	6,059,307	$348,265
Germany	1,001,715	56,764	503,762	31,451	299,899	14,787
Belgium	842,689	49,428	678,270	38,335	655,700	34,689
France	686,557	44,584	577,728	32,846	1,626,792	84,145
Chinese Empire	1,178,734	49,416	3,185,453	131,755	3,319,631	140,442
All other	270,142	14,523	782,282	46,938	1,957,835	70,890
Total	8,489,068	503,988	10,036,401	541,588	13,919,164	693,218

ANTIMONY ORE, REGULUS, OR METAL (ANTIMONY CONTENTS).

Imported from—	1913		1914 [5]	
	Pounds.	Value.	Pounds.	Value.
United Kingdom	7,826,534	$548,523	866,496	$53,140
Germany	1,157,263	73,242	80,742	4,423
Belgium	465,567	25,626	56,487	3,143
France	1,427,211	92,053	396,723	24,154
Chinese Empire	4,101,731	170,515	730,826	34,648
All other	4,606,318	224,508	533,151	26,409
Total	19,584,624	1,134,467	2,664,425	145,917

[5] Figures for 1914 cover period from July 1 to Oct. 3, 1913, inclusive. After this date statistics of regulus and metal are stated separately from those of ore.

ANTIMONY, AS REGULUS OR METAL, CHANGED 1914 TO "MATTE REGULUS OR METAL."

Imported from—	1910 [6]		1911–1913 [7]		1914 [8]	
	Pounds.	Value.	Pounds.	Value.	Pounds.	Value.
United Kingdom	619,857	$40,511	.....	.....	4,147,263	$244,552
Austria-Hungary	.....	.....	.....	.....	320,987	15,722
Germany	.....	.....	.....	.....	273,001	13,215
Belgium	.....	.....	.....	.....	466,362	23,072
France	80,915	5,319	.....	.....	916,008	53,021
Japan	.....	.....	.....	.....	1,143,340	58,543
China	.....	.....	.....	.....	2,149,865	107,947
All other	.....	.....	.....	.....	206,813	10,252
Total	700,772	45,830	.....	.....	9,623,639	526,324

[6] Figures for 1910 cover period from July 1 to Aug. 5, 1909, inclusive.
[7] Included in "Antimony ore, regulus, etc."
[8] Figures for 1914 cover period from Oct. 3, 1913, to June 30, 1914.

ANTIMONY, MATTE, REGULUS, OR METAL.

Imported from—	1915		1916		1917	
	Pounds.	Value.	Pounds.	Value.	Pounds.	Value.
United Kingdom	2,334,980	$208,688	402,196	$96,749	345,708	$63,896
Germany	53,034	2,855	.....	.....	.....	.....
Belgium	87,135	3,881	.....	.....	.....	.....
France	257,744	13,061	.....	.....	.....	.....
Spain	492,028	48,185	111,760	35,205	.....	.....
Japan	5,820,356	564,064	10,038,302	3,257,210	5,826,151	753,653
China	4,791,783	479,712	12,415,216	3,527,815	9,347,571	1,109,326
Mexico	.....	.....	.....	.....	1,580,835	197,605
All other	151,453	16,893	643,732	174,444	538,025	62,556
Total	13,968,513	1,337,339	23,611,206	7,091,423	17,638,290	2,187,086

Imports by countries—Continued.

ANTIMONY, MATTE, REGULUS, OR METAL—Continued.

Imported from—	1918		1919	
	Pounds.	Value.	Pounds.	Value.
United Kingdom	279,776	851,788	53,088	85,190
Japan	15,430,505	1,917,464	6,397,362	532,196
China	11,352,167	1,378,868	13,093,832	1,112,957
Mexico	5,567,197	491,523	2,937,316	268,610
All other	1,304,870	149,536	2,813,104	214,825
Total	33,934,515	3,939,174	25,294,702	2,153,774

The main increase in imports of metal in 1917 came from Japan. This country diverted its product to the United States and Canada following the cancellation of its Russian contracts when the business of that country collapsed. The total increase in imports in 1917 over the previous year was 70 per cent. The value, however, was nearly $1,000,000 less on account of the lower price of the metal.

Very little crude is imported. Prior to the war quantities of crude were shipped to the United States from China. At one time a considerable amount of this material was imported and used in lieu of the metal in the manufacture of oxide and chemicals. During the war period exports of crude from China fell off, as it was found more profitable to reduce it to metal and export in purer form. This tendency on the part of Chinese producers will eventually remove Chinese ore from the foreign market. The Mexican and South American sources of supply will of course remain open, but it is very doubtful if they can produce ore or metal under present conditions at a profit in competition with the Chinese supplies.

MARKETS.

Up to the outbreak of the war the great antimony market had been London. Ore and metal from all corners of the globe came to this center and were thence distributed. Hamburg, Berlin, Frankfort, and Paris were also important antimony centers. The English quotation fixed the world price. The disorganization of shipping due to the submarine menace resulted in a transfer of the English business and a consequent strengthening of the Chinese interests.

In general the antimony market may be described as unstable. There is little flexibility in demand. Any increase in supply above the normal small tonnage results in a serious cut in price. It is very easy to increase the supply. China alone could produce two or three times the quantity normally needed, while Mexico formerly produced two-thirds of the American requirements.

A most important factor in the antimony market is the effect of exchange due to the silver standard used in China. The recent high rate of exchange has been an added factor in increasing the cost of the product.

PRICES.

The average price of antimony metal for 30 years ending in 1914 was 7.5 cents per pound.[7] In the price statistics below two quotations will be noted: (1) Cookson's, and (2) others or "ordinaries." As has been mentioned above, Cookson is an English smelter. The output was uniformly high grade and brought a premium price. Hallett's (another English smelter) metal was generally quoted from one-fourth to 1 cent less and also appears in most price statistics. There have been an innumerable number of brands at various times, each demanding a separate price, depending upon purity or, still more important, upon reputation. Gradually, however, the trade differentials were narrowed and now that Chinese metal is the main factor in the market, there is but little difference in the price of the several brands.

Antimony, matte, regulus, metal: Monthly average prices per 100 pounds at New York City.

[Data from Mineral Industry.]

Month.	1910		1911		1912		1913	
	Cookson's.	Ordinaries.	Cookson's.	Ordinaries.	Cookson's.	Ordinaries.	Cookson's.	Ordinaries.
January	$8.50	$7.74	$8.25	$7.50	$7.53	$6.88	$9.94	$8.97
February	8.47	7.58	8.38	7.65	7.27	6.83	9.47	8.25
March	8.36	7.31	9.56	9.00	7.65	6.86	9.28	8.18
April	8.44	7.44	9.54	8.52	8.05	6.94	9.13	7.98
May	8.44	7.44	9.50	7.99	8.02	7.10	8.88	7.79
June	8.24	7.44	8.75	7.42	8.09	7.21	8.79	7.64
July	8.18	7.40	8.50	7.35	8.42	7.50	8.54	7.55
August	8.28	7.33	8.44	7.36	8.59	7.70	8.38	7.39
September	8.31	7.31	8.31	7.26	9.12	8.26	8.37	7.37
October	8.26	7.40	8.14	6.96	10.30	9.30	7.69	6.49
November	7.92	7.19	7.97	6.92	10.39	9.30	7.62	6.45
December	7.63	7.06	7.78	6.82	10.21	9.18	7.50	13.90
Year	8.25	7.39	8.59	7.54	8.90	7.76	8.73	7.52

Month.	1914		1915, Cookson's.	1915 [a]	1916 [a]	[1] 1917	1918 [a]
	Cookson's.	Ordinaries.					
January	$7.39	$6.13	$17.56	$15.24	$42.26	$17.29	$14.28
February	7.25	6.10	20.43	17.62	43.77	29.89	13.82
March	7.31	6.05	27.84	20.90	44.71	32.89	13.09
April	7.36	6.01	32.07	23.97	41.35	34.04	12.54
May	7.37	5.84	[b]	34.71	32.20	25.20	12.85
June	7.25	5.83	[b]	36.53	20.40	19.51	13.06
July	7.21	5.64	[b]	35.98	14.55	15.83	13.20
August	17.25	13.80	[b]	32.57	12.62	15.06	14.00
September	11.83	9.94	[b]	28.50	11.57	14.94	14.15
October	14.68	12.06	[b]	30.96	12.44	14.75	13.32
November	17.75	14.45	[b]	37.38	13.65	13.91	8.77
December	16.10	13.31	[b]	39.36	14.39	15.06	7.92
Year	10.73	8.76	[b]	29.64	25.33	20.69	12.58

[a] Almost wholly Chinese and Japanese metal.
[b] Quotations ceased. Embargo on antimony exports from Great Britain.

[1] This price is for Cookson's. The average for minor brands was nearer 6 cents.

Antimony prices (average) per 100 pounds at New York City.

Data from Engineering and Mining Journal:]

Year.	Price.	Year.	Price.
1895	$7.560	1907	$14.540
1896	6.650	1908	8.004
1897	6.750	1909	7.466
1898	8.690	1910	7.386
1899	9.430	1911	7.540
1900	9.500	1912	7.790
1901	8.250	1913	7.520
1902	6.120	1914	8.763
1903	6.000	1915	30.240
1904	6.371	1916	25.370
1905	10.250	1917	20.690
1906	21.730	1918	12.581

Previous to the World War, the only important flurry in the antimony market was in 1906, shortly after the Russo-Japanese War, when many governments were demanding antimony for the manufacture of munitions. The unusual requirements coupled with rumors that the larger Chinese mines were becoming exhausted carried the price to above 26 cents, but increased supplies brought the price down to a more nearly normal figure even before the general industrial depression of 1907.

The importance of antimony in the recent war was recognized more quickly than was that of any of the other metal. In the first month of the war (August, 1914), the price of Cookson's jumped from an average of 7.2 cents for July to 17.2 cents for August, and that of other brands increased in proportion. There were considerable fluctuations later, but rarely did the price fall below double the prewar quotations even during the uncertain months of the latter part of 1914. Cookson's quotations ceased in May of 1915 and Chinese and Japanese brands became practically the only metal offered in New York. The price increased gradually, though in the summer of 1915 a bit unsteadily, to a maximum of 46 cents a pound in March, 1916.

From this peak the price declined steadily to about 11 cents early in October, followed by a slight recovery to about 15 cents toward the end of the year. The decline caused by heavy production in China killed the mushroom domestic mining industry that had sprung up again after a lapse of practically 10 years. Stocks in the United States were large but were soon absorbed by purchases of the Canadian Government. Prices for spot metal improved slowly to a maximum of 36 cents in March, 1917. The collapse of Russia cut off the demand for munitions that Canada had been furnishing while the latter country also began to import its supplies direct from China and Japan. The United States Government requirements were not sufficient to stay the decline in spot prices that followed the withdrawal of the Canadian demand and increased importations. Prices

for forward shipment in 1917 were quite steady, as offerings for future shipments were plentiful. Abundant supplies characterized the market in 1918 despite the fact that consumption continued strong. Prices were surprisingly steady, hovering generally a little under 14 cents. With the signing of the armistice came a sharp drop to about 8 cents. Were it not for the rather large stocks on hand, indications in 1919—especially in view of high costs—tend toward an upward movement.

Foreign prices have not been investigated; but before the war market conditions were such that the New York price, except for minor speculative transactions, would not differ widely from the London price plus the duty, freight, and other charges for transport. During the war the foreign markets were generally higher than New York because of the strict control exercised by the various governments and the fixed minimum price. The minimum British fixed price in 1918 was £85 per long ton (18 cents per pound) or about 4.5 cents per pound higher than the New York price[8] (which was not regulated by the United States Government). British surplus stocks on January 1, 1919, as reported by the minister of munitions, amounted to 3,058 tons as compared with a prewar annual consumption of approximately 2,000 tons. Throughout the year, the price ranged at about £45 per long ton for English regulus. Chinese metal sold for from £2 to £5 less, reflecting the course of silver exchange and the gradual depletion of stocks. Surplus stocks were almost wholly dissipated in January, 1920, when prices mounted from £45 per ton to £70 per ton within a few weeks. Early in March, English regulus was selling at £72 with Chinese £3 lower. Two months later, the price of English metal was still maintained but Chinese had fallen to £63. This corresponded, at existing exchange, to about 11 cents per pound which compared with the New York price of under 8 cents.

TARIFF HISTORY.

Antimony ore has been imported free of duty since 1870 except under the act of 1909, when its antimony content was dutiable at 1 cent per pound.

Antimony regulus or metal paid an import duty of 10 per cent ad valorem for 26 years beginning in 1864. The act of 1890 changed the ad valorem rate to a specific duty of three-fourths of a cent per pound—a reduction. In the act of 1894 antimony was on the free list; but the act of 1897 restored the specific duty of three-fourths of a cent per pound, as in the former tariff. In the 1909 act the duty was doubled. After 23 years under specific rates (except the three years

[8] Average price prior to signing of the armistice.

on the free list) antimony metal was again made dutiable on an ad valorem basis in 1913, returning to the early rate of 10 per cent. Except in 1916, when the average price was 25.1 cents per pound, the 10 per cent rate was operated as a reduction in the duty as compared with the 1½ cents specific rate of the 1909 act.

COMPETITIVE CONDITIONS.

Chinese antimony deposits unquestionably offer the cheapest and most economical supply of this metal. There are about 20 Chinese smelting plants, a large number of which were erected during 1916 and 1917 under the stimulus of the war boom. These Chinese plants have a capacity of about 23,000 tons of regulus per year, provided that a price of 20 to 25 cents per pound be maintained. With prices ranging from 11 to 13 cents and the less favored Chinese smelters closed, Chinese production is rated at 12,000 tons per year.

It is frequently stated in the trade that the price of antimony must be around 20 cents (some say 25 cents) per pound for American mines to produce at a profit. Since antimony declined in price the domestic mines have all closed and those smelters that remained in operation procured their ore from Mexico and China.

Consumers contend that a greater benefit than the forced operation of the mines would probably accrue to this country if there were a firmly established smelting industry which would import and smelt Chinese, Bolivian, Mexican, and Canadian antimony ores. The only smelting operations that have been at all persistent were at four points: San Francisco (Nichols-Layng Chemical Co.), Los Angeles (Western Metals Co.), Matawan, N. J. (Magnolia Metals Co.), and Piscataway, N. J. (Antimony & Compounds Co. of America).

For many years before the war the available supplies of antimony far exceeded the demand, and there was little to encourage development of antimony deposits, other than those from which high-grade ores could be obtained, unless exceptional facilities existed for smelting and marketing the metal in the neighborhood of the mines. After the outbreak of the war there was a curtailment of metal imports; Chinese and South American antimony became difficult to move on account of shipping shortage and Mexican supplies were unstable. Under these circumstances considerable activity resulted and many deposits that had remained idle for a long period were again put in operation in the United States.

In ordinary times this country has no antimony mines that can be worked profitably in competition with China and Mexico, the largest annual output of metal on record before 1915 being about 486 tons. Under the stimulus of high prices, the United States produced in 1915, 2,000 tons of metal, derived from 20 small mines in all parts of the country. The demand was precipitated on an unprepared

mining industry and the price rose by leaps and bounds from 8 cents to 46 cents per pound. In 1916, following great expansion in production, decline in price was rapid, to 9 cents in August.

The United States mines and smelters then began to drop out and world consumption seems for the present to have established 7 to 12. cents per pound as a price that maintains production at the required point.

Certain outstanding features of the antimony industry tend to place control of the raw material more and more firmly in the hands of the Chinese. Smelting facilities have been increased during recent years, in Changsha and Hankow, and efforts are being made to concentrate the smelting of antimony ores in China. The Wah Chang Mining & Smelting Co. is the world's largest producer of antimony. The prewar cost of production was approximately 3 to 3.5 cents per pound (f. o. b. Shanghai). Chinese wages are said to run from 30 cents to 60 cents per day, and the efficiency of the Chinese 12-hour coolie is reported to be approximately from 35 to 50 per cent of that of the American laborer, whose wages are $4 to $5 for eight hours' work.[9]

There is much scope for further savings in cost of Chinese smelting, and sweeping changes are possible in the adoption of mechanical roasting furnaces, especially well designed reverberatory furnaces for the liquation process, gas-firing for reduction furnaces, and the Cottrell electrical precipitation process, all of which have been suggested to the antimony producers by Chinese experts.

TARIFF CLASSIFICATIONS.

Paragraph 144 reads:

Antimony, as regulus or metal, and matte containing antimony but not containing more than 10 per centum of lead, 10 per centum ad valorem; antimony oxide, salts, and compounds of, 25 per centum ad valorem.

Under the free list, paragraph 396 reads:

Antimony ore and stibnite containing antimony, but only as to the antimony content.

It will be noted that specific provision is not made for antimony, crude or needle, a comparatively important product, nor for precipitated sulphides and oxide of antimony. Importations of crude or liquated antimony have been classified as matte under the tariff act of 1913, but there is doubt whether such nomenclature accords with the usual metallurgical concept of matte, which is an artificial sulphide, the product of a smelting operation. Under the act of 1897, similar merchandise was held exempt from duty. The intent of the law probably is to include needle antimony with the

[9] Statement of Chester Fritz, of Hongkong, representing Charles E. Richardson, importer, Tariff Commission interview, Sept. 13, 1919.

metal, since both are marketable products in a more or less finished state.

The sublimed oxide of antimony and precipitated sulphides are finished products all used as pigments. They are now classified with general chemical compounds. Cognizance might also be taken of the less finished forms of the metal—intermediate products in the English smelting process—which may be imported into the United States from Mexico instead of going to England as formerly.

Antimony matte and crude or needle antimony containing not more than 10 per cent of lead might he added to paragraph 144, and the provision for "antimony oxide, salts and compounds of," might be changed to read, "antimony, salts and compounds of." Chemical schedule (A) appears to be a more appropriate schedule than the metal schedule (C) for these salts and compounds.

COURT AND TREASURY DECISIONS.

In 1872 crude antimony, so called, was held not to be "ore of antimony, or crude sulphuret of," exempted from duty in the act of 1870, but a substance obtained therefrom; that is to say, found in the ore and separated from the outer ingredients by different processes and therefore dutiable at 10 per cent ad valorem under the provision for "antimony, crude, and regulus of antimony," in the act of 1864. (Dept. Order, T. D. 1106.)

An importation described as "sulphate of antimony," obtained from the native sulphuret or antimony ore by a process of fusion and commercially known as crude antimony, was held to be dutiable under the provision for "crude antimony" in Schedule M of the Revised Statutes and not exempt from duty as "crude sulphuret of antimony." (Appeal, T. D. 3877.)

Crude sulphuret of antimony subjected to the process of grinding or pulverization was held in 1882 not to be ore or crude sulphuret of antimony, but dutiable either as a mineral substance not otherwise provided for, or as an unenumerated manufactured article. (Appeal, T. D. 5473.)

"Regulus" or "regulus of antimony" was declared by the Board of General Appraisers in construction of the act of 1890 to be the ordinary metallic antimony obtained by fusion and chemical combination from the crude antimony of commerce. (G. A. 463, T. D. 11020.)

So-called "mineral red," consisting of sulphide or sulphuret of antimony used as a vulcanizing agent in the manufacture of rubber to soften it where soft rubber is required, as in bottle stoppers, cushions for billiard tables, etc., was held dutiable as a chemical

salt and not as a color as classified by the collector. (G. A. 4231, T. D. 19901.)

The word "sulphite" in the provision of the free list of the act of 1897 for "antimony ore, crude sulphite of," was taken by the Circuit Court for the Southern District of New York to be a misprint for "sulphide" and crude sulphide of antimony was held to come within that provision. (McKesson *v.* U. S., 113 Fed., 996; Dept. Order, T. D. 23653.)

The product of antimony ore produced by removing the gangue or slag by heat, and known as needle antimony, was declared the crudest form of sulphide of antimony known to commerce. (McKesson *v.* U. S., supra, and G. A. 5127, T. D. 23691.)

Ground sulphide of antimony was held exempt from duty under the provision for "antimony ore, crude sulphide of," in the act of 1897. (G. A. 5440, T. D. 24718.)

Copper ore containing less than 1 per cent of lead and not more than 1½ per cent of antimony was held exempt from duty as copper ore under the act of 1909, the antimony and lead content being considered negligible. (Abstract 34619, T. D. 34127.)

The act of 1913 (imposing an ad valorem rate of duty) was held not to have a retroactive effect so as to make antimony metal imported under the act of 1909 (imposing a specific duty) and withdrawn from warehouse under the act of 1913 subject to additional duties for undervaluation. (Sheldon *v.* U. S., 6 Ct. Cust. Appls., 516 (T. D. 36143), reversing Abstract 38226.)

The phrase "plated with gold or silver" in paragraph 167, tariff act of 1913, was interpreted in connection with articles of antimony and held to signify the final condition rather than the process by which the condition was produced. (Tuska *v.* U. S., 5 Ct. Cust. Appls., 506 (T. D. 35153), affirming G. A. 7587, T. D. 34651; followed in Abstract 37504).

Chemical tests were ordered by the Treasury Department to be made to determine whether antimony articles are plated. (Dept. Order, T. D. 34043.)

The provision for "antimony oxide, salts, and compounds of," in paragraph 144 of the tariff act of 1913, the Court of Customs Appeals has held, is not to be read as if there were a comma after the word "antimony" and antimony sulphide was declared not classable as a salt or compound of antimony oxide, but dutiable as a chemical compound or salt under paragraph 5 of that act. (U. S. *v.* Innis, 7 Ct. Cust. Appls., 3.) The legislative history shows that when the tariff act of 1913 was passed by the House of Representatives there was a comma after the word "antimony" and none after the word "oxide";

that the comma after the word "antimony" was stricken out in the Senate and that a comma was inserted by the conference committee after the word "oxide," thereby making the law read "antimony oxide, salts, and compounds of." (G. A. 7688, T. D. 35142.)

Antimony oxide has also been held not to come within the provision for "antimony oxide, salts, and compounds of." (G. A. 7899, T. D. 36364.)

Liquated antimony has been held not within the provision of paragraph 396 of the act of 1913 for antimony ore and stibnite containing antimony but is dutiable as a matte containing antimony under paragraph 144. (T. D. 37360.)

In a case where samples contained 65.30, 68.20, or 70.70 per cent of antimony, with no appreciable lead or zinc in one sample, and no lead or zinc at all in the other samples, it was held by the Board of of General Appraisers, upon analyses made by the Government chemist at New York, to be exempt from duty under paragraph 396 of the act of 1913 as antimony ore. (Abstract 43092.)

A mixture of 70.3 per cent antimony, 21.2 per cent sulphur, 1.14 per cent iron, and a trace of silica, the whole being the resultant product of ore subjected to the process of metallic fusion known as "liquation," constitutes a matte containing antimony within paragraph 144 of the act of 1913. (G. A. 8333, T. D. 38370.)

Rates of duty.

Act of—	Paragraph.	Tariff classification or description.	Rates of duty, specific and ad valorem.
1883.....	195	Antimony, as regulus or metal.....	10 per cent ad valorem.
1883.....	600	Antimony ore, crude sulphite of.....	Free.
1890.....	187	Antimony, as regulus or metal.....	¼ cent per pound.
1890.....	485	Antimony ore, crude sulphite of.....	Free.
1894.....	376	Antimony ore, crude sulphite of, and antimony, as regulus or metal.	Do.
1897.....	173	Antimony as regulus or metal.....	¼ cent per pound.
1897.....	476	Antimony, ore, crude sulphite of.....	Free.
1909.....	173	Antimony, as regulus or metal.....	1½ cents per pound.
1909.....	173	Antimony ore, stibnite and matte containing antimony, but not containing more than 10 per centum of lead, 1 cent per pound on the antimony contents therein contained.	1 cent per pound.
1909.....	173	* * * Antimony, oxide of.....	1½ cents per pound and 25 per cent ad valorem.
1913.....	144	Antimony, as regulus or metal, and matte containing antimony but not containing more than 10 per centum of lead.	10 per cent ad valorem.
1913.....	144	* * * antimony oxide, salts, and compounds of...	25 per cent ad valorem.
1913.....	396	Antimony ore and stibnite containing antimony, but only as to the antimony content.	Free.

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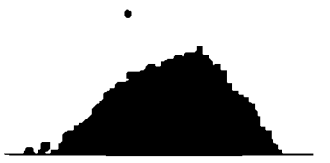
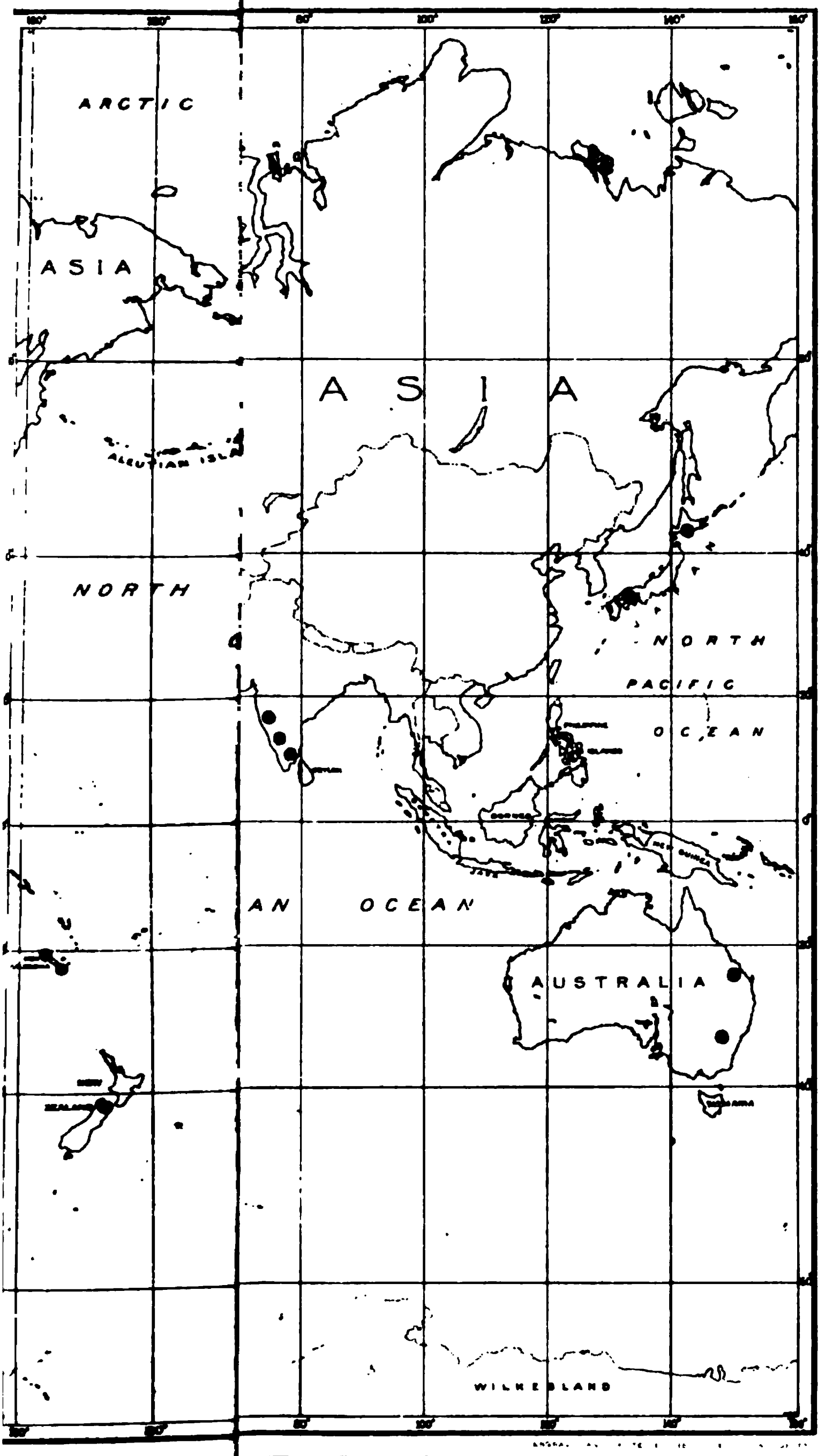
CHROMITE





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CHROMITE.

SUMMARY.

IMPORTANCE OF THE INDUSTRY.

Chromite is of prime military importance as the raw material for the ferrochrome used in making chrome steel armor plate, projectiles, and high-speed cutting tools. It is an essential raw material in the chemical, dyestuff, paint, and tanning industries. Chromite bricks are also an important refractory material in metallurgical industries.

FOREIGN AND DOMESTIC NATURAL RESOURCES.

Our chromite resources, as developed to date, are insignificant in comparison with those of Rhodesia, New Caledonia, Asia Minor, Russia, and Brazil. The deposits of high-grade ore in these countries run into millions of tons. The largest body of chrome ore mined in the United States in recent years contained less than 18,000 tons.[1]

The chromite problem differs from the manganese in degree only—the industries consuming a tonnage approximately one-eighth that of manganese. Chromite is widely distributed, but occurs usually in small, erratic, low-grade bodies. Domestic deposits are particularly difficult of access and the mineral can not be removed without the outlay of considerable capital for road building. Recovery of the ore is by quarrying, and requires no mining plant of great value. Owing to the nature of our deposits, it is expected, though not certain, that the cost of domestic chromite production will mount in the future rather than decrease.

The chromite reserves of the United States have been greatly augmented during the past year by developments in California and Wyoming. The extent of these new deposits has not yet been confirmed by the Geological Survey, but they are undoubtedly important. At certain California points chromite has been found at considerable depth, contrary to previous experience in the industry. There is a possibility of substantial expansion in domestic chromite reserves with the development of deep mining in the industry.

DOMESTIC SUPPLIES.

The chromite situation is marked by a transition from almost complete dependence on foreign supplies in 1913–14 to the domestic

[1] It is reported by Dr. P. Frazer, in Second Geological Survey of Pennsylvania, that in 1828 a chromite deposit—the Wood Mine, Lancaster County—was opened, from which 95,000 tons of ore were subsequently removed.

production of a major part of the country's requirements in 1918. We produced in that year approximately 125,000 long tons of all grades, of which 82,430 tons were shipped. Although the actual consumption in 1918 has been estimated as not over 100,000 tons, there was in addition to the domestic production of 125,000 tons a total importation of 100,224 long tons crude ore from Canada, Cuba, Brazil, New Caledonia, Africa, Australia, and Guatemala, with the result that stocks of January 1, 1919, were considerably over a two-year's total supply at prewar rates of consumption.

Of the total amount of domestic chromite mined in the six years ending 1918, 83 per cent came from California, 16 per cent from Oregon, and the remainder from Maryland, North Carolina, Washington, and Wyoming. Of the 298 chromite correspondents reporting to the Geological Survey on July 1, 1919, only one was at that time actually producing from domestic mines.

During the last half of 1919 approximately 20,000 long tons of chrome ore were imported. The lower grade of the domestic ore and its reported greater cost to the consumer in the eastern part of the United States as compared with the imported material has resulted in a decided preference on the part of the eastern consumer for the foreign ore.

Future Competitive Conditions.

It is expected that New Caledonia and Rhodesia will resume their prewar dominance in the United States market as soon as shipping facilities return to normal. The price of foreign chromite in the eastern United States market before the war averaged approximately one-third the domestic cost of chromite from the Pacific coast in the same market. In certain exceptional cases of high-grade ore contracts are already in effect which will give domestic producers a steady market for chemical uses. But the tonnage thus involved in insignificant.

With foreign chromite entirely excluded it is estimated by the Geological Survey that the known resources of the United States would be depleted in five years or less.

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THE CHROMITE INDUSTRY.

Act of 1913, paragraph 448:

Chromate of iron or chromic ore, free.

DESCRIPTION AND GRADES.

Chromite or chromic iron ore, also called "chromate of iron," "chrome," and "chrome iron," is a mineral of the spinel group, composed of iron, chromium, and oxygen ($FeCr_2O_4$), usually black and [illegible]ic luster.

[illegible]pany, in sorting ore for the manufacture of chromate of [illegible]e three grades. The best is finely-grained and brittle, [illegible]thracite coal, and contains 50 to 55 per cent of chromic [illegible] middle grade resembles dull graphite and averages [illegible]of Cr_2O_3. The third grade, which assays only 35 per cent [illegible] rusty yellow color. The chromite ore of California, which [illegible] about 85 per cent of the domestic output, averages from [illegible]per cent chromic oxide.

[illegible] application of this visual selection care must be taken to [illegible] strongly magnetic ore, for in some localities beautifully [illegible]h [illegible]s chrome ore may contain only 30 per cent of Cr_2O_3, the luster being caused by splendent magnetite.

USES.

Chromite is used in alloys, chemical compounds, and for refractory purposes.

The most important alloy is with iron (known as ferrochrome), which is used in making chrome steel. This is remarkable for its hardness and resistance to wear and penetration, even at high temperatures. Its principal application is in armor plates and shells for piercing them, as well as in parts of airplane and automobile engines, and in stellite for high-speed cutting tools.

Chrome steel is extremely hard, tough, and dense. It possesses great tensile strength and is superior to any other metal for the wearing parts of crushing mills. It can be welded to iron, rolled, and finds use in sheet and rod metal, especially in burglar-proof safes, wire magnet steel, cutlery, bridge steel, etc. There are special steels whose properties are determined by alloys of which chromium is an element. The most important of these is stainless steel, a mild steel alloy containing 12 to 13 per cent chromium, much used for fine cutlery, which is consuming increasing supplies of chromium.

produc› of stainless steel for ship plates is proposed; the advantages We ꝛuced weight and lessened expense for painting and scraping grad to the belief that an extensive use of this remarkable material cor be a feature of future shipbuilding. This use, if general, will t) eatly increase the demand for chromium and will considerably alter the marketing and distribution of this metal.

Nichrome, a chrome-nickel alloy, is largely used as the resistance element in electrical heating devices, because of its high melting point.

Chromates of soda and potash are the most important chemical compounds of chromium used in the trade. They are employed direct in tanning, as mordants in dyeing, and are the base from which chrome pigments are made.

For refractory purposes chromite is used crude or is manufactured into chrome brick.

In the United States, normally, about 35 per cent of chromite consumption is used in ferrochrome, 35 per cent as chromates and other chemicals, leaving 30 per cent for use as refractories.

SUBSTITUTES.

There has been found to date no substitute for chrome in the steel industry, and in tanning there is nothing known which gives the same results. In the paint and color trades chromates can be replaced by other colors, but the substitutes are nearly all more expensive.

Chromite as a refractory material can in many cases be replaced by magnesite. The latter is more expensive.

HISTORY.

The chrome industry in the United States, b facturing, originated in Maryland, on the d chrome ore in the Bare Hills in Baltimore Cou early years, was the world's chief source of su

The production in the United States grad 1850, when severe foreign competition appeare from Europe then took the place of the dom the beginning of the European war, in 1914, trade of this country in steel and the consequ ferrochrome stimulated the search for dome and resulted in a greatly increased productior

Early in the fifties deposits of chromite we fornia, but, notwithstanding this discovery, supply used in the United States was importe 1860 to 1880, finally, about 1880, active pro fornia and has continued until the present t pean war the maximum output was 3,68

which was produced in 1894. There was no production in the last three years of the nineteenth century.

Production, imports, and exports of chromite.

[Calendar years.]

Year.	Domestic production (long tons).[1]	Imports for consumption (long tons).	Domestic exports.	Ratio to production (per cent), imports.	Value, imports for consumption.	Amount of duty.	Value at shipping port (per ton).	Equivalent ad valorem rate.
1910	205	38,579	None	19,000	$415,768	Free	$11.78	Free.
1911	120	38,309	...do	32,000	413,628	...do	10.80	Do.
1912	201	53,929	...do	27,000	499,818	...do	9.27	Do.
1913	255	65,180	...do	26,000	622,821	...do	9.55	Do.
1914	591	80,736	...do	14,700	695,345	...do	8.61	Do.
1915	3,281	76,455	...do	2,300	780,061	...do	10.20	Do.
1916	47,035	115,945	...do	247	1,548,402	...do	13.35	Do.
1917	43,725	72,063	...d	165	1,110,659	...do	15.41	Do.
1918	[2] 82,430	100,224	...do	122	2,892,825	...do	28.86	Do.
1919	8,900	61,404	...do	1,570	1,381,497	...do	22.50	Do.

[1] Crude ores, various grades (calendar years).
[2] Exclusive of 42,687 tons produced at mines but not shipped.

PRODUCTION.

Domestic.—In 1913 less than 1 per cent of the chromite ore consumed in the United States came from domestic production; the imports supplying the balance were largely drawn from New Caledonia and Rhodesia. At the time the armistice was signed the domestic mines were producing, or were prepared to produce, a greater tonnage than the country required, even in war time.

The domestic supply of chromite comes almost wholly from the western part of the country. The most important operating deposits are in California, and the average production in that State amounts to over 83 per cent of the domestic total for the six years ending 1918. Most of the remainder comes from Oregon with still smaller quotas from Wyoming, Maryland, and other States. The normal prewar output was less than 500 tons. In 1918 over 83,000 short tons were shipped from domestic mines, in addition to stocks on hand at the close of the year awaiting shipment, of approximately 48,000 tons. The deposits recently discovered in Montana and Wyoming will, if worked extensively, shift the center of production eastward, but this would be a disadvantage, since the ore must be shipped by rail, whereas California producers may ship by water. Large reserves in Montana might result in the operation of ferrochrome furnaces near the source. This would be of great advantage to domestic producers because it would eliminate part of the freight toll. In general the large domestic bodies of ore are low grade (40 per cent Cr_2O_3 after concentration). This feature is an added handicap since all the foreign supply runs 50 per cent or more and for this reason commands the premium price.

Marketed output of crude chromite in the United States.

[Figures from U. S. Geological Survey.]

Year.	California.	Oregon.	Washington, Wyoming, Maryland, North Carolina.	Total.	Average price.
	Long tons.	*Long tons.*	*Long tons.*	*Long tons.*	
1910	205	.....	.....	205	$13.3[illegible]
1911	120	.....	.....	120	13.[illegible]
1912	201	.....	.....	201	13.[illegible]
1913	255	.....	.....	255	11.[illegible]
1914	506	.....	85	591	14.[illegible]
1915	3,281	.....	.....	3,281	11.[illegible]
1916	43,758	3,099	178	47,035	15.44
1917	36,774	6,701	250	43,725	24.[illegible]
1918	63,147	18,454	829	82,430	47.[illegible]
1919	2,000	.....	.....	[1] 3,900	[2] 2[illegible]

[1] Estimate, J. S. Diller, U. S. Geological Survey.
[2] First 6 months.

Chromite produced in United States in 1918.[1]

	Shipments.	Stocks.[2]	Value of ore sold.	Total mined.	Average price
	Long tons.	*Long tons.*		*Long tons.*	
California	63,147	34,489	$3,078,160	.....	$4[illegible]
Oregon	18,454	6,830	855,050	.....	4[illegible]
Washington and Wyoming	352	407	8,124	.....	2[illegible]
All other States	477	[3] 961	14,233	.....	2[illegible]
All grades, total[4]	82,430	42,687	3,955,567	.....	47.9
Ore carrying 50 per cent chromic oxide	68,746	35,603	.....	104,349	.....
Metallic chromium	23,504	12,179	.....	35,683	.....

[1] Table from Chromite in 1918, U. S. Geological Survey, Mineral Resources (press).
[2] Estimated ore on hand at mines, Dec. 31, 1918.
[3] Georgia, Pennsylvania, and Montana had no shipments, but some stocks on hand.
[4] Average domestic chromite for 1918—41.7 per cent chromic oxide Cr_2O_3.

Foreign.—The principal chromite-producing countries in normal times are New Caledonia, Rhodesia, and Russia. Small amounts were mined in Greece, India, Japan, and other countries; but before the war, over 85 per cent of the world output came from the three countries first named. During the last few years Canada, Brazil, Cuba, and to a minor degree Guatemala, have become important sources of the chromite supply, particularly to the United States because of their relative accessibility. Asia Minor has been a substantial producer since 1913.

The richest chrome ore mined at present comes from Guatemala. The New Caledonian, Rhodesian, and Russian ores are also of high grade; but the average ore mined in the United States, Canada, Cuba, and Brazil is of lower grade. This can usually be improved by concentration. New Caledonia and South Africa supply over 65 per cent of the world's production of chromite. The output of both these localities is controlled by a French company. The Russian ore is used partly in Russia and partly exported. The normal export-

able surplus is about 15,000 tons or 75 per cent of the total Russian output. The Turkish production, coming from Asia Minor and located within easy reach of the Mediterranean (less than 200 miles from Constantinople) is no less important, although in late years this supply has not come to the United States on account of the war. Some chromite is produced in Bosnia and Herzegovina, Canada, Sweden, and New South Wales.

Greatly increased supplies of chrome were received from Canada in 1916 and 1917; the deposits are confined to Quebec. The Canadian industry has been able to operate during 1919, and has made large shipments to the United States. Cuba has hitherto produced little chromite, though it contains large deposits of low-grade ore. Nicaragua and Guatemala ship a small quantity of ore to this country. In Antioquia, Colombia, chromite is reported to be abundant. Brazil has valuable deposits several hundred miles northwest of Bahia.

World's production of chromite.[1]

[Metric tons.]

Country.	1913	1914	1915	1916	1917 [2]	1918 [2]
United States	259	600	3,333	47,788	44,425	84,000
Canada	.....	123	11,196	24,963	33,317	20,000
Cuba	.....	.....	.....	35	17	9,000
Guatemala	.....	.....	.....	.....	182	1,200
Brazil	.....	.....	.....	.....	.....	18,000
British South Africa	63,384	49,009	61,590	80,624	43,230	28,000
Turkey (Asia Minor)	14,000	14,000	14,000	14,000	.....	14,000
Greece	6,930	7,059	10,420	9,880	.....	10,000
Austria-Hungary	305	533	.....	.....	.....	500
Russia	15,000	15,000	15,000	15,000	.....	15,000
India	5,767	5,986	3,828	20,484	.....	20,000
Australia	685	660	770	460	770	800
New Caledonia	63,370	71,708	57,474	57,024	41,892	26,000
Japan	1,331	2,108	2,979	8,280	.....	8,000
Total	171,000	166,000	180,000	278,000	.....	.....

[1] U. S. Geological Survey.
[2] On account of the war the records of world's production of chromite are incomplete for 1917 and 1918. Final figures will no doubt show a greater annual production than ever before.

COMPARISON OF FOREIGN AND DOMESTIC NATURAL RESOURCES.

Our chromite resources as developed to date are small in comparison with those of Rhodesia, New Caledonia, Asia Minor, Russia, and Brazil. The deposits of high-grade ore in the first three of these countries run into millions of tons. The deposits of southern Rhodesia form a belt 200 miles long. The reserves are very large, and the average tenor of the high-grade ore is about 50 per cent Cr_2O_3. Some 260 mines contributed to the 1918 supply of domestic chromite, but the largest single deposit worked in the United States in recent years has contained less than 18,000 tons.[2] It is reported

[2] One deposit worked in Pennsylvania during last century produced 95,000 tons.

by operators that deposits of much greater extent have lately been developed in California and Wyoming. The Geological Survey has not confirmed these reports quantitatively, but it does report an important discovery in Montana (at present some distance from a railroad) that contains a minimum estimated tonnage, after concentration, of 250,000, and a possible tonnage of eight times that amount of 40 per cent ore after concentration.[3] Heretofore chromite has been considered a surface deposit, but recently the ore has been found at a considerable depth. Domestic chromite reserves will be greatly increased if this occurrence at depth proves general.

In 1918, American mines produced approximately 125,000 tons, which was 25 per cent in excess of the total estimated domestic consumption in that year of 100,000 tons. On January 1, 1919, there was over a year's total supply of the mineral stocked in the hands of consumers—at prewar rate of consumption a two years' supply. On January 1, 1920, the domestic industry was practically dead; some shipments were being made from stocks produced during 1919.

MINING PRACTICE.

As the domestic chromite deposits are generally small and scattered, considerable development work must be done per ton of ore mined. Road building is usually the first step in the development. The deposit is then stripped of overburden, and if the ore body is on a side hill, the lower portion is mined first, the work continuing up the slope until the whole deposit is worked out. If the deposit is high grade and clearly defined, the ore is sorted by hand, but in low-grade deposits the ore (or sand in residual deposits) is concentrated in sluices or on tables, which permits the barren rock to pass off and retain the chromite.

When the chromite is mixed with iron as magnetite, the latter is usually removed by use of a magnet. Chromite containing much iron is difficult to concentrate.

The practical continuity of the deposits in Rhodesia eliminates in that country the high development cost necessary in the United States, and increases the handicaps (relatively high labor cost, overland freight, etc.) under which domestic producers must operate.

Owing to the great war demand for chromite, many concentrating plants have been erected in the United States. Some were constructed without special regard to efficiency or permanency, but other plants—notably those with larger reserves in sight—have erected permanent highly efficient mills.

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[3] A. I. M. E., Recent Studies of Domestic Chromite Deposits in 1919.

PRICES.

There are wide ranges in prices of chromite according to district and to buyers. Thus in 1914 the price per ton of ore carrying 50 per cent Cr_2O_3 in California ranged from $10 to $17 and in 1915 from $11 to $18. In 1916 the price averaged approximately $15.44; in 1917, $24 per ton; in 1918, $47.99 per ton; and during first six months of 1919, $26 per ton. Prices fell steadily after the armistice. Lump ore containing 45 to 48 per cent of chromic oxide was quoted in April, 1920, at 20 cents per unit f. o. b. California points, and concentrates containing 48 to 50 per cent, at 40 to 50 cents per unit. In New York, however, ores containing 35 to 40 per cent chromic oxide were quoted (Mar. 27, 1920) at 60 to 85 cents, and ores containing 48 per cent or more, at 70 cents to $1.25 per unit.

In July, 1920, the California price, f. o. b. mines had risen to 60 to 65 cents for 50 per cent minimum and imported ores f. o. b. Atlantic ports was quoted at 70 to 85 cents for 40 per cent minimum.

The effect on the cost of the finished product of an increase in the price of chromite ore varies with the industry in which the ore is used. In the chemical and refractory trade, where the cost of chromite is a major part of the total expense, any increase in the price of the ore would result in practically the same increase per ton of finished product. In the chrome steel industry, on the other hand, the cost of chromium added is only a small fraction of the total expense. Even a large increase in cost of chromite has but little effect on the cost of chrome steel.

Average yearly prices, per long ton.

[Data from "Mineral Resources," U. S. Geological Survey.]

1909	$13.88	1915	$11.20
1910	13.31	1916	15.44
1911	13.58	1917	24.00
1912	13.70	1918	47.99
1913	11.19	1919 [4]	26.00
1914	14.75		

MARKETS AND MARKETING CONDITIONS.

Domestic.—The value of chromite depends on its Cr_2O_3 (chromic oxide) content. The market quotation is based on units of 1 per cent of a long ton. The value of a ton of ore is found by multiplying the unit value by the percentage chromic oxide content.

Most of the chromite used in the United States is consumed in plants in the eastern part of the country. There appears to be a prejudice among domestic consumers against the domestic product, even when it is of high grade. This is largely due to the variation in chromium content of the domestic ores from different properties, whereas the foreign material coming from one large source is uniform. Efficient concentrating machinery at domestic plants would go far to counteract this feeling among the smelters.

[4] First 6 months average, U. S. Geological Survey.

During the war period there was a strong tendency for direct contact between the producer and consumer and for the elimination of the broker. The ore from the small mines frequently passes through two or three brokers before it reaches the consumer. On account of the unstable condition of the market consumers prefer to deal with one large ore-buying concern for the whole of their product rather than to bother with the sampling and contracting of small amounts from a large group of widely separated and occasional producers.

Foreign.—France was the second largest consumer before the war, requiring 35,000 tons annually for her industries as compared with the normal 65,000 tons consumed in the United States. Germany and Great Britain were next in order, requiring about 30,000 tons each. Italy uses ferrochrome, largely derived from France.

There have been many attempts to control the chrome supplies of the world. The most important of these was the Paris Syndicate formed in 1912, which acquired control of the New Caledonia deposits and later of the producing mines in Rhodesia. This syndicate was practically broken up by the outbreak of the war. It is considered unlikely that any future monopoly of this material will exist because of the large number of extensive deposits that were opened up during the war period. The entire European consumption of chromite is sold in London, both for English and continental distribution. It appears that this condition will continue, except as regards the output of New Caledonia, which, for German consumption at least, was formerly handled by Societe le Chrome in Paris.

IMPORTS.

For many years prior to the exploitation of the New Caledonian and South African deposits the bulk of the chromite consumed in the United States was imported from Asiatic Turkey. Small amounts were derived from Greece and other countries. With the outbreak of the war in Europe, Germany required most of the Turkish product and no more shipments were made to the United States. As the difficulty of ocean shipments became acute, the United States drew more heavily on nearer sources of supply, especially Canada. Owing to the largely increased consumption the amount imported was two or three times that imported before the war, in spite of the great growth in domestic production. Toward the latter part of 1918 this caused a heavy accumulation of stocks.

The amount of chromic ore imported has varied largely from year to year. Before the war it averaged (five years) 53,000 long tons valued at over $500,000, annually. The maximum importation was in 1917 (fiscal year), when 113,326 long tons were imported. Although the value per ton was less than in the following year, the total value was also at its maximum in the fiscal year 1917, amounting to nearly $1,650,000.

In addition to the importations of chromic ore, there are imports ferrochrome, chromic acid, chromate of potash, and bichromate potash. In recent years none of these products has been imported large amount. The United States industries for the production chemicals and the metal and ferroalloy seem to be independent foreign competition except for their ore supply. In the eighties nd nineties large quantities of bichromate of potash were imported, ut a steady falling off can be noted in recent years.[5] The imports chromite on the other hand are increasing.

Imports by countries.

[Fiscal years.]

Imported from—	1910		1911		1912		1913	
	Long tons.	Value.	Long tons.	Value.	Long tons.	Value.	Long tons.	Value.
ortuguese Africa	19,455	$236,691	16,318	$198,538	5,100	$62,048	24,000	$291,981
ench Oceania	9,466	89,521	8,957	114,239	6,600	41,399	6,620	47,913
urkey in Asia	1,100	7,000	4,500	31,121	11,030	71,214	13,830	100,227
reece	7,740	68,126	4,500	48,188	7,540	70,595	.....	.....
itish South Africa	.....	.....	3,400	41,365	.....	.....	.....	.....
nada	241	2,892	15	150	13	258	.....	.....
rtugal	.....	.....	.....	.....	15,455	188,577	5,000	60,831
pan	2,290	16,959	449	3,680	190	1,381	322	2,712
itish India	231	466	.....	.....	1,000	6,600	.....	.....
gland	747	9,038	.....	.....	54	676	.....	.....
therlands	125	2,110	.....	.....	25	387	.....	.....
lgium	3,558	49,720	.....	.....	.....	.....	.....	.....
Total	44,953	482,523	38,139	437,281	47,007	443,135	49,772	503,664

Imported from—	1914		1915		1916		1917	
	Long tons.	Value.	Long tons.	Value.	Long tons.	Value.	Long tons.	Value.
ortuguese Africa	30,001	$364,989	15,430	$206,718	7,850	$122,149	42,800	$918,908
rench Oceania	25,970	166,915	18,410	118,231	37,474	252,221	34,807	326,781
urkey in Asia	14,830	107,292	5,700	42,636	.....	.....	.....	.....
reece	8,450	87,931	4,305	37,694	8,905	117,254	3,400	40,800
itish South Africa	.....	.....	2,850	34,673	35,650	491,027	16,050	76,210
nada	533	9,283	356	4,202	15,783	194,591	14,749	271,052
ngland	58	717	.....	.....	7	700	.....	.....
uba	.....	.....	.....	.....	.....	.....	34	681
ustralia[a]	.....	.....	.....	.....	1,500	18,308	1,486	14,296
Total	79,842	737,127	[b]47,051	444,154	107,069	1,196,250	113,326	1,648,728

Imported from—	1918		1919	
	Long tons.	Value.	Long tons.	Value.
ortuguese Africa	21,000	$184,001	5,000	$37,225
rench Oceania	20,400	227,835	6,586	128,272
ritish South Africa	1,000	4,867	550	20,424
anada	17,935	394,258	18,108	604,325
ngland	9	1,209	.....	.....
uba	18	710	9,218	335,228
ustralia[a]	4,112	189,233	16,212	663,731
ll other	13,307	540,618	15,918	650,625
Total	77,781	1,542,761	71,592	2,439,830

[a] Probably produced wholly in New Caledonia (French Oceania).

[b] This is the figure appearing in Department of Commerce records. It is, however, 112,370 tons less than mports for Consumption record for same fiscal year. This discrepancy has been investigated through nquiry of Department of Commerce, but the department states that the commodity may have been ntered (in error) under some other classification—i. e., iron ore, etc.

[5] A sudden great importation of bichromate was due in 1908–1910 to excess production abroad.

EXPORTS.

During the early years of chrome production in this country, the entire product was sold abroad where it was used in making colors. As the domestic iron and steel and dyeing industries developed, imports became necessary, and none of the domestic product has been exported for many years.

COMPETITIVE CONDITIONS.

The mining of chrome ore in the United States has been essentially a war industry. With the resumption of normal trade relations, very few of the domestic producers could hope to compete with foreign producers (on equal terms), even assuming the domestic product to be as high grade as the foreign. In the first half of 1919 only 1,400 tons of ore were mined, at three properties. During the same period of 1918, 600 mines were active.

In spite of the great activity in prospecting due to the high prices and Government stimulation during the war period, no large bodies of chromite ore were opened up that can compare in tonnage or grade with the Rhodesian and New Caledonian deposits. The large tonnage produced came from widely scattered deposits—most of them lacking good transportation facilities—and the cost in the eastern market was nearly three times that at which foreign supplies could be bought before the war. All the known deposits of high-grade chromite in the United States would be exhausted in less than five years if the entire needs of this country were supplied from domestic mines.[6] Even accepting the top estimate of all known deposits, including those recently discovered and not developed, there is not yet enough high-grade ore in sight to serve as the basis of a permanent industry.

In addition to the poverty and small extent of their deposits, domestic chrome miners face the further disadvantage of location on the Pacific slope, whereas their market is along the Atlantic seaboard and in the Eastern States. Cost of transportation of the western ore to the eastern market ranges from $10 a ton to Chicago to about $15 to Atlantic ports.[7] Ocean freights in normal times are in the neighborhood of $3 a ton; from Grecian ports to Chester, Pa., in 1909, the rate was $2.88 per ton unloaded on the wharf.

TARIFF HISTORY.

Chromite ore was subject to duty from 1883 to 1894, when it was put on the free list.

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[6] This estimate (Geological Survey) is vigorously denied by California producers, who contend that many large deposits have been uncovered during the war and that much larger reserves now exist.

[7] However, ships from the Pacific coast, fruit-laden, via the Panama Canal, would in many cases find it to advantage to augment their cargo with chromite ballast.

Rates of duty.

ıct of—	Paragraph.	Tariff classification or description.	Rates of duty, specific and ad valorem.
83.....	214	Chromate of iron, or chromic ore	15 per cent.
90.....	132	.....do.....	Do.
94.....	438	Chromate of iron or chromic ore.....	Free.
97.....	520	.....do.....	Do.
09.....	532	.....do.....	Do.
13.....	448	.....do.....	Do.

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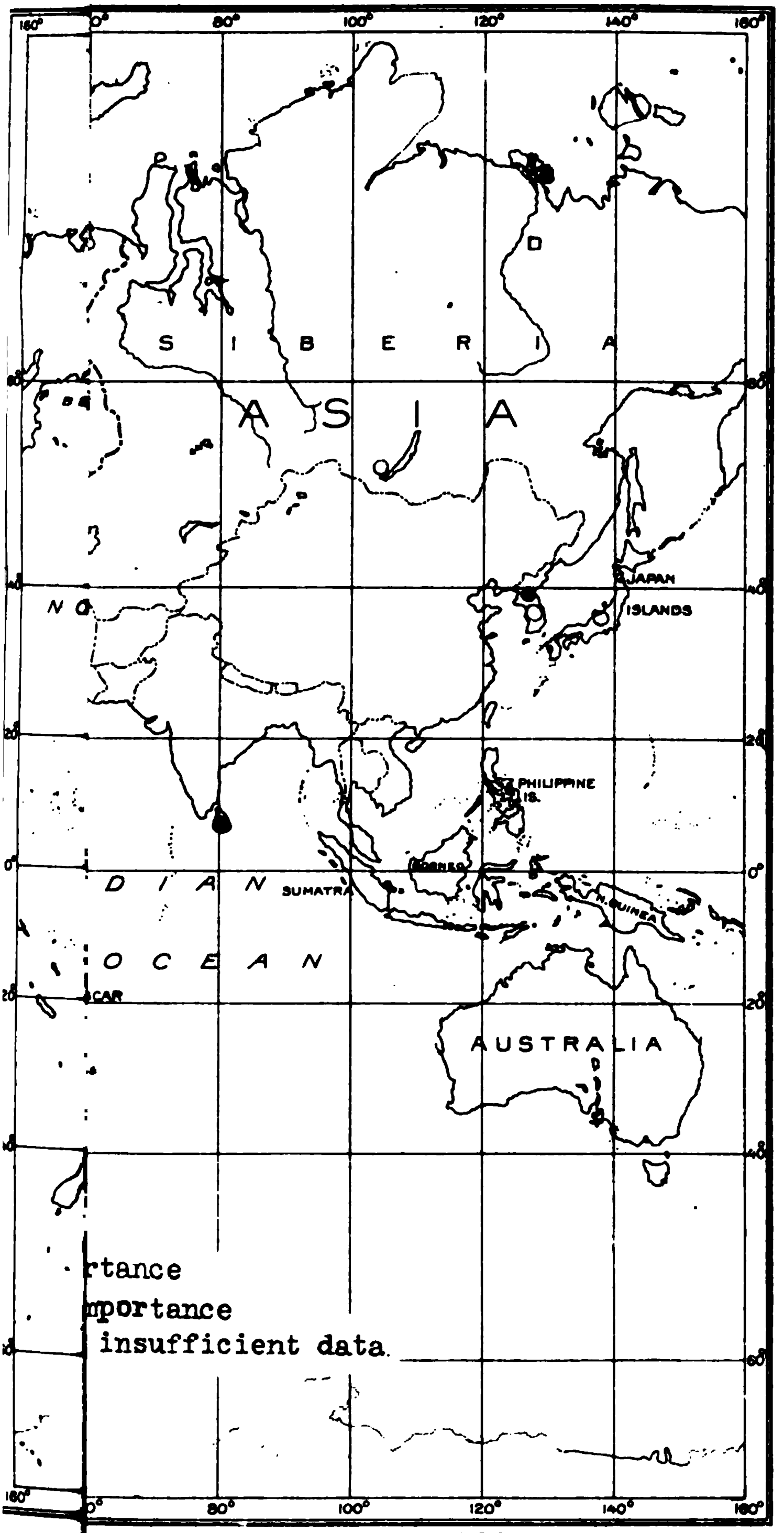

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artificial graphite. There was little stimulus given amorphous production during the war and its present problems are the same as they were before the war. Both Chosen and Mexico have larger and higher grade deposits, but are handicapped by their greater distance from the market.

Artificial graphite, made from coal or other carbonaceous material in the electric furnace, is suitable for many minor uses and is a serious competitor of amorphous. The American industry is large, important and highly integrated. In view of the comparatively low value of the product, the skill required in the manufacture, and the enterprise of its management, it is apparently proof against foreign competition in the American market and is reaching out into the export field.

Domestic Supplies.

The United States has heretofore not been considered independent in the matter of crucible graphite. Crucible makers have insisted on having Ceylon graphite, using some 15,000 tons a year. Montana has lately been producing graphite that is being accepted by crucible manufacturers as equal to Ceylon material. The quantity ultimately available has not yet been proved, but is believed by the operators to be sufficient to satisfy domestic demands for many years to come. It would appear, also, from tests recently made by Dr. Stull, of the American Ceramic Society, with crucibles made wholly of Alabama flake that equally as good service can be obtained from the domestic as from the Ceylon material.

The domestic output of flake has never exceeded the 1918 output of 6,431 tons. The request of the War Industries Board that the makers of crucibles should use 20 per cent of domestic flake graphite during the second half of 1918 established a market for domestic flakes. During 1918 imports of graphite were over three times the domestic production.

There is a larger degree of independence in the matter of amorphous graphite, of which the consumption is in the neighborhood of 15,000 tons annually. Practically all of this can be furnished from domestic sources, including both natural and artificial graphite, but at present American owned mines in Mexico and Canada are drawn upon to some extent.

Future Competitive Conditions.

It is probable that Ceylon lump, regardless of price, will continue to be imported for some years as raw material for crucible manufacture on account of its peculiar grade and established reputation. Extreme reluctance to use more than 20 per cent of domestic graphite in place of Ceylon is evidenced by crucible manufacturers, but it is by no means clear as yet, either to those within the trade or without, that this is a necessary restriction. Foreign manufacturers were using up to 100 per cent Madagascar flake during the war period.

THE GRAPHITE INDUSTRY.

Tariff act of 1913, paragraph 579:

Plumbago, free.

DESCRIPTION AND USES.

GENERAL.

Graphite is a soft, black, greasy form of carbon, sometimes referred to in the trade as "plumbago" and "blacklead." It occurs in nature in two forms, crystalline and amorphous, each having its own peculiar uses. Artificial graphite, made from coal or other carbonaceous material in an electric furnace, is to a certain extent a competitor of the natural amorphous product. It is even better suited for certain purposes, notably the manufacture of graphite electrodes, the demand for which has greatly increased on account of the rapid growth of electrochemical industries.

Crystalline graphite is commonly understood to mean graphite in crystals large enough to be seen with the naked eye. It is used in the manufacture of crucibles, as a lubricant, in paints, foundry facings, batteries, and stove polish.

Amorphous graphite, while frequently showing a crystalline structure under the microscope, is a trade name applied to amorphous or very fine-grained graphite of varying degrees of purity. It is used for foundry facings, as a lubricant, in pencils (blacklead), paints, high explosives, boiler compounds, electrodes, dry batteries, and shoe and stove polishes.

Flake graphite is crystalline graphite produced in flakes or scales, while vein graphite is crystalline graphite in other forms, such as lump, chip, and dust. The chief supply of high-grade crystalline graphite comes from Ceylon, and this is the standard grade of crystalline product.

SPECIAL USES.

(*a*) *Crucibles, retorts, stoppers.*—Demand for graphite crucibles comes from the makers of crucible steel and of various nonferrous metal and alloy castings. Crucible makers are the largest consumers of graphite. The material must be of high grade, either lump or chip, flake or vein, containing at least 85 per cent graphitic carbon and free from easily fused impurities.

(*b*) *Lubricants.*—Both crystalline and amorphous are used, free from silica (sand).

(*c*) *Foundry facings.*—Chiefly amorphous graphite is used. High-grade material is not required. Artificial graphite is also used to a considerable extent.

(*d*) *Pencils.*—For better grades, mixtures of crystalline and amorphous are needed. For poorer grades, amorphous is used alone. Artificial graphite may be, but rarely is, used for this purpose.

(*e*) *Polish for smokeless powder.*—Amorphous is used with relatively small consumption. Graphite makes the grains flow better and permits more accurate filling of shells.

(*f*) *Electrodes.*—Artificial is considered most suitable. Products are usually formed from powdered amorphous carbon (e. g., anthracite coal) and "graphitized" in an electric furnace.

(*g*) *Boiler compounds.*—Pure material is not essential. Either amorphous or artificial graphite is used.

(*h*) *Paints.*—Amorphous, artificial, or crystalline graphite is used. High-grade material is not necessary.

(*i*) *Stove and shoe polish.*—Chiefly amorphous material is used.

(*j*) *Dry-battery fillers.*—Either amorphous, artificial, or crystalline is utilized. Pure material is required, but size of grains is not a factor.

(*k*) *Fertilizer filler.*—Low-grade amorphous material is used as an adulterant, to give the required dark color.

Estimated percentages (by quantity) of graphite consumption for various purposes.

	World.[1]	United States.[2]
Crucibles	55	6
Stove polish	15	5-15
Foundry facings	10	25
Lead pencils	5	5
Paint	5	
Lubricants	5	15
All other uses	5	10-5
Total	100	100

[1] E. S. Bastin, Mineral Resources, 1913. If value rather than quantity is considered, about 75 per cent of the world's consumption should be credited to crucibles.

[2] United States Mineral Resources, 1918.

DOMESTIC AND FOREIGN GRADES COMPARED.

Since crucible making is by far the most important use of graphite the adaptability of the different grades for making crucibles is the determining factor in quality. Most makers of crucibles have heretofore preferred Ceylon lump mixed with from 10 to 25 per cent of American flake. The principal reason assigned for preferring the Ceylon material is that the flat flake of the domestic graphite has a far greater surface area in proportion to its volume than the more nearly cubical Ceylon graphite, and hence requires a greater amount of clay as a binder.[2] Improved finishing methods may permit the use of a larger proportion of American graphite, and during the latter part of the war period crucible manufacturers were required to use at least 20 per cent of domestic flake in all crucibles. For most pur-

[2] Some difficulty was experienced after the outbreak of the war in finding a domestic clay to take the place of the Bavarian clay formerly used, but domestic clays have been found and satisfactory crucibles have been made from domestic clay and 100 per cent domestic graphite.

poses, other than crucible manufacture, amorphous graphite and American flake graphite can be used and the American product, when properly cleaned, is as good as the imported. Crystalline varieties, however, with flakes large enough to add to the binding power of clay are essential to the making of good crucibles and for high-temperature work the proportion of clay should be very low. For such purposes the domestic product heretofore has not been considered as satisfactory as the Ceylon. However it has recently come into greater favor.[3] Foreign crucible makers are using 100 per cent Madagascar flake, which differs little in quality from the domestic flake.

In a statement presented to the Ways and Means Committee in September, 1919, 14 manufacturing jobbers engaged in the plumbago foundry facing business maintained that the Alabama dust carries grit, is harder to grind than the imported, and is not naturally as well suited for foundry facings as the Ceylon graphite. The Alabama and Pennsylvania graphite dust was said to be of inferior refractory quality because of its large silica and mica content, which fuses under the pouring heat of the molten metal and prevents smooth facings.

SUBSTITUTES.

Artificial graphite can be used for certain purposes in place of amorphous and crystalline graphite. There is no present substitute for flake graphite in the making of crucibles, although experiments along the line of artificial graphite may evolve a satisfactory product.

Mica is used to some extent in lubricants, but is an inferior substitute. The same may be said of talc. The latter, however, is a partial substitute for graphite in foundry work. Blast furnace "kish" (graphite that separates from pig iron when it solidifies) offers possibilities as a substitute for flake as a lubricant. There are numerous satisfactory boiler compounds that contain no graphite. Lampblack is used instead of graphite in paints and polishes.

WORLD PRODUCTION.

Amorphous graphite may occur wherever coal or other carbonaceous beds have been folded and altered by dynamic agencies. Crystalline graphite is found in two principal types of deposit (1) as flakes in schist and (2) as larger crystals in veins. The second is

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[3] As high as 100 per cent has been successfully used. The adaptability of the domestic No. 1 flake as a practical crucible material has been indicated by tests of Dr. R. T. Stull (reported in Jour. American Ceramic Society, March, 1919), showing the average number of heats in crucibles used in melting brass. With graphite crucibles varying from 100 per cent Ceylon to 100 per cent Alabama material, the following results were obtained:

	Heats.
100 per cent Ceylon graphite	7.75
77.27 per cent Ceylon graphite and 22.73 per cent Alabama graphite	9.75
54.55 per cent Ceylon graphite and 45.45 per cent Alabama graphite	17.75
31.82 per cent Ceylon graphite and 68.18 per cent Alabama graphite	14.25
100 per cent Alabama graphite	21.00

of rather rare occurrence, but is important in that it yields the most valuable kind of flake for crucible manufacture. Vein deposits, however, almost invariably are found only in association with graphitic sediments containing the ordinary flake variety.

Any general statements in regard to production are complicated by the difference in the quality of the different supplies. Data based solely on either quantity of production or on value give little indication of the relative importance of the various sources of supply.

In normal times Austria is the leading graphite-producing country as regards quantity, producing in 1913 nearly twice as much graphite as Ceylon, the second largest producer. The value of the Ceylon product, however, was nearly seven times as great, and this British-owned island is the largest producer of high-grade crucible graphite in the world. Recently the French island of Madagascar has come forward as a rival producer of crystalline material. The quality of the product is a little different from that of Ceylon. It is not satisfactory to domestic crucible makers, but is preferred abroad because of its low price. Less satisfactory supplies are available in many countries, notably Bavaria, Canada, and Japan.

Amorphous graphite is much more widely distributed than the crystalline variety, being produced in about 20 countries. The largest producers are Austria, Italy, Chosen, and Mexico. Certain deposits have been found better suited for special uses, but most countries are satisfied with near-by supplies, and this raw material is relatively unimportant compared with the high-grade flake product.

The following estimate of probable annual production was prepared by the United States Shipping Board (1918):[4]

1. Production of crystalline graphite:[5]

Madagascar	35,000 tons, increasing.
Bavaria	12,000 tons, poorer grade.
United States	10,000 tons.
Ceylon	30,000 tons, likely to decrease.
Norway	1,000 tons.
Sweden	200 tons.
Japan	1,000 tons.
Transvaal	200 tons.
Canada	4,000 tons.
Greenland, Brazil	Reported large deposits.
German Southwest Africa	Not likely to develop largely.
Baffin Island	Small amount produced recently.
Indian Island	Once abandoned, small production.
England	Worked out.
Rumania	Recent important discoveries reported.
Spain	Deposits being developed.

[4] Ferguson and Grout: Political and Commercial Control Series No. 2.

[5] "Only Madagascar flake, Ceylon grades, and Alabama or domestic flake No. 1 (which last is not more than 50 per cent of the domestic total) suitable for crucible making." (Jos. Dixon Co.)

2. Production of amorphous graphite:

Austria	50,000 tons.
Italy	13,000 tons.
France	1,000 tons.
Spain	1,500 tons.
Chosen (Korea)	20,000 tons.
Siberia	Large uncertain amount available.
United States	6,000–8,000 tons manufactured.
Mexico	8,000 tons.
Rhodesia	Local supply only.
Brazil, Queensland	Small production.

DOMESTIC PRODUCTION.

GRADE.

The domestic supplies of graphite suitable for crucible flake are large, but the low tenor of the ore necessitates the handling of a large tonnage of rock per ton of product. The domestic deposits are mostly schists, which contain the graphite in small flakes disseminated through the rock. The separation of the valuable material from the accompanying minerals, notably mica, is more difficult and expensive than is the case in some other countries. The grade of domestic deposits that have been successfully operated varies from 3 to 10 per cent and averages about 5 per cent of recoverable flake graphite. Amorphous graphite deposits must generally be of higher grade because of the lower value of the separated product.

QUANTITY.

Crystalline.—The actual mine production of domestic crystalline graphite in 1917 was the largest in the history of the industry, amounting to approximately 14,000,000 pounds. (Only 10,584,080 pounds, however, were marketed in that year.) This production compares with an output of about 10,000,000 pounds in 1916 and a normal prewar production (average of six years) of only a trifle more than 5,000,000 pounds and reflects the great stimulation in the demand for crucibles esulting from the war. Production in 1918, including both flake and dust, amounted to 12,861,839 pounds, valued at $1,454,799.

In New York State, and intermittently in Pennsylvania, graphite has been mined for many years, and in 1913 Alabama became an important factor in the domestic output. But the domestic production was comparatively small in quantity and much smaller comparatively in value, as chiefly lower grades were produced. The growth in 1916 was over 100 per cent, and in 1918 the output was more than treble the prewar average.

The possible output of crystalline graphite in the United States is estimated at 30,000,000 pounds with the present milling capacity

operating one shift of eight hours, and 50,000,000 pounds with the same milling capacity operating three eight-hour shifts.[6]

Estimates furnished the Geological Survey by producers indicate that about 64 per cent by weight and 90 per cent by value of the total crystalline graphite marketed in 1917 was flake graphite, containing from 80 to 90 per cent graphitic carbon and in large part suitable for crucible making. This is a much higher percentage of flake than has been produced in any previous year. The increase may in large measure be attributed to improvements in processes of "ore" treatment.

Amorphous.—The production of amorphous graphite in 1918 amounted to 6,650 short tons, valued at $69,455, as compared with 8,301 tons, valued at $73,481 in 1917; 2,622 tons, valued at $20,72[illegible] in 1916; and a normal prewar output (average of five years) of only about 1,700 tons. As amorphous graphite is not suitable for making crucibles, there was not so marked an increase in the demand for it and the production had to meet the competition of both crystalline dust (a by-product in the preparation of crucible flake) and artificial graphite.

Production in the United States.[1]

Year.	Natural.						Artificial.[2]	
	Crystalline.		Amorphous.		Total.			
	Short tons.	Value.	Short tons.	Value.	Short tons.	Value.	Short tons.	Value.
1909	3,147	$313,271	[3] 5,096	$32,238	[3] 8,243	$ 109	3,435	$467,19[illegible]
1910	2,795	295,733	1,407	39,710	4,202	143	6,575	945,70[illegible]
1911	2,395	256,050	1,223	32,415	3,618	165	5,072	664,[illegible]
1912	1,772	187,689	2,093	32,894	3,835	183	[4] 6,448	830,1[illegible]
1913	2,532	254,328	2,243	39,428	4,775	756	6,817	973,[illegible]
1914	2,610	285,368	1,726	38,750	4,335	118	5,[illegible]	698,9[illegible]
1915	3,837	417,273	1,121	12,358	4,718	131	[3] 2,[illegible]	109,1[illegible]
1916	8,466	914,748	2,622	20,723	8,088	171	[4] 4,441	(5)
1917	5,292	1,094,396	8,301	73,481	13,593	1,179	[4] 5,[illegible]07	(5)
1918	6,431	1,454,799	6,650	69,455	12,991	1,254	[4] 4,501	(5)
1919 [6]	3,717	696,000	4,000	47,000	7,717	100	4,062	

[1] Marketed production as reported to United States Geological Survey.
[2] Mineral Industry for 1918.
[3] Includes Georgia graphitic slate.
[4] Powdered graphite only; does not include electrode material after 1914.
[5] Prices not available.
[6] Preliminary figures, subject to revision.

LOCALITIES OF PRODUCTION.

The greater portion of the domestic output of crystalline graphite comes from Alabama. The remainder comes largely from New York and Pennsylvania, although small quantities were produced in California, Montana, and Texas in 1918.

There is, however, one deposit in Montana which has lately been producing crystalline graphite that is of the same physical character

[6] Statement of H. B. Johnson, representing the Southwest Graphite Co., Burnet, Tex., before the Ways and Means Committee, Sept. 26-27, 1919.

as the Ceylon material. The quantity ultimately available has not been proved, but is believed by the operators to be sufficient to supply domestic demands for many years to come. Alabama flake is also accepted by certain companies as satisfactory crucible material and has shown even superior results in crucible tests reported by Dr. Stull in the Journal of the American Ceramic Society, March, 1919.

The productions of crystalline graphite in 1916, 1917, and 1918 are shown in the following table:

Domestic crystalline graphite sold in the United States, 1916–1918.[1]

	1916		1917		1918	
	Quantity.	Value.	Quantity.	Value.	Quantity.	Value.
	Pounds.		*Pounds.*		*Pounds.*	
Alabama	5,226,940	$492,407	6,223,095	$715,575	7,795,475	$999,152
New York	(2)	(2)	2,941,040	261,548	3,266,518	273,188
Pennsylvania	1,095,716	103,377	804,945	77,475	1,016,900	112,059
Other States[3]	4,609,333	318,964	615,000	35,800	782,946	70,400
Total	10,931,989	914,748	10,584,080	1,094,398	12,861,839	1,454,799

[1] Mineral Resources, 1918.
[2] Included in all "other States."
[3] 1916, California, Montana, New York, Texas; 1917, Alaska, California, Montana, Texas; 1918, California, Montana, Texas.

Amorphous graphite was produced by four mines in 1918, six mines in 1917, and five mines in 1916, in Colorado, Nevada, and Rhode Island. On account of the small number of plants, productions by States may not be published, although they are recorded in the confidential files of the Geological Survey.

Alabama is credited with 59 and 66 per cent of the quantity and 66 and 69 per cent of the value of the domestic crystalline graphite sold in the United States in 1917 and 1918, respectively. The output was worth three times that of 1913. In December, 1918, 30 plants were operating and the production for the year exceeded that of 1917. The number of idle and abandoned mines was also greater. Only six of the plants were operating full time. Alabama ores do not contain amorphous graphite. All of the companies operate open pits, and remove only the upper 30 to 60 feet of the material. This consists of the decomposed (weathered) horizon and is normally rather soft and easily broken. The underlying unaltered "blue rock" is hard and since it is expensive to mine it is not worked. The average Alabama ore is very low grade, containing only about 2½ per cent of graphitic carbon, but the accessibility and comparatively even grade of the deposits make them the most important in the United States. The aim in concentrating is to produce as much No. 1 flake as possible (analyzing 85 per cent graphitic carbon and remaining on a No. 8 silk cloth of 86 mesh). No. 2 flake (analyzing 75 to 80 per cent graphitic carbon and finer than No. 1

flake) is a by-product grade that is difficult to dispose of, while "dust" (containing 30 per cent or more graphitic carbon) is a drug on the market. The production in Alabama plants varies from 4½ to 8 pounds of No. 1 flake per man per hour. The average is estimated at about 6 pounds per man-hour, figured on the total number of men and officials employed. Proportional amounts (about 2 pounds) of No. 2 and dust are made in addition.[7]

New York is the oldest producing State, graphite mining having started about 60 years ago. The ore is much higher grade than that of Alabama, averaging 4 to 6 per cent graphitic carbon, and yields a cleaner, brighter flake. As a rule it is harder and more closely resembles the undecomposed Alabama "blue rock." Most of the ore comes from underground mines, and is extracted by power drills. In thickness the deposits average about 15 feet and seldom exceed 25 feet. There were three active producers in 1917–18. The sales of graphite from New York in 1918 amounted to 3,226,51[illegible] pounds, valued at $273,188, an increase of 11 per cent in quantity and 4.5 per cent in value over the output of 1917.

Pennsylvania had six operators in 1918. The ore, with one exception, is a soft weathered schist, and contains from 3½ to 4½ per cent graphitic carbon. Several of the producers make an unrefined concentrate analyzing 60 to 70 per cent graphitic carbon. It is sold to an eastern refiner.

Alaska has deposits of graphite which are being developed near the coast in the Port Clarence mining district, Seward Peninsula. Since 1900 shipments of a few tons have been made intermittently, but aside from development work sufficient only to hold the claims according to the mining regulations. There appears to have been no other work done to show the extent of the deposits.

There seems to be a possibility of a large production of graphite from these deposits. The topographical situation and nearness to water transportation have favored development work at these deposits rather than at those which occur several miles farther back in the mountains. There are known to exist deposits which run as high as 90 per cent carbon, but they are almost inaccessible at the present time, and the cost of producing and marketing is prohibitive.[8]

The number of operators in other States for 1918 was as follows: Rhode Island, 2; California, 1; Montana, 4; and Texas, 1. The deposits in these States have been described in detail in various publications of the United States Geological Survey. Most of the deposits are of a higher grade than those in Alabama, but are more difficult to mine. The recovery of flake is generally low, since amorphous graphite is also present. The flake is small and the rock hard, so

[7] War Minerals Investigations Series No. 3, Bureau of Mines.

[8] Statement of J. A. Just before Ways and Means Committee, Sept. 26–27, 1919.

Prior to 1915 there were only seven properties equipped with milling plants and capable of producing crystalline graphite in the United States, distributed as follows: Alabama, 4; Pennsylvania, 2; New York, 1. The total value of these plants was estimated to be about $400,000.[10] From 1915 to 1919 there were 46 mills constructed and properties made ready for operation, making a total of 53 mills and refining plants in the United States reporting by actual expenditures an investment of $5,160,000. These plants are distributed as follows:

Alabama	36	North Carolina	1
Pennsylvania	5	Montana	1
New York	4	Colorado	1
Texas	3	California	1
Massachusetts	1		

Prior to the war there was invested in the graphite business in Alabama about $150,000, by four companies. In September, 1919, of 36 mills in Alabama representing an actual cash investment of about $4,000,000, there were not at that time over 5 or 6 mills in operation, and of this number none were operating more than one shift a day.

DOMESTIC PRODUCTION AND CONSUMPTION.

The United States has heretofore not been considered independent in the matter of crucible graphite. Crucible makers, who use some 15,000 tons a year, have insisted on having Ceylon graphite. The domestic output of flake has never exceeded the 1918 output of 6,431 tons. The request of the War Industries Board that, as a war measure for ship saving, the makers of crucibles should use 20 per cent of domestic flake graphite during the second half of 1918, established a market for domestic flake. During 1916 and 1917 the imports of graphite were eight times the domestic production. In the last few months of the war, domestic production had increased to a point at which it was supplying over one-third the demand for graphite of all grades.

There has been a larger degree of independence in the matter of amorphous graphite, of which the consumption is in the neighborhood of 15,000 tons annually. Practically all of this can be furnished from domestic sources, including both natural and artificial, but American-owned mines in Mexico and Canada were drawn upon to some extent

[10] Statement of Van Croft G. Davis before Ways and Means Committee, Sept. 26-27, 1919.

Domestic consumption of natural graphite.

QUANTITY.

Calendar year.	Domestic production.	General imports.	Domestic exports.	Foreign exports.	Net consumption.
	Short tons.	*Short tons.*	*Short tons.*	*Short tons.*	*Short tons.*
1912	3,835	25,642	2,320	.....	27,157
1913	4,775	28,890	2,692	1	30,962
1914	4,335	21,990	1,960	.....	24,365
1915	4,718	22,075	529	.....	27,264
1916	8,085	42,930	706	124	50,096
1917	13,593	42,577	2,573	18	53,579
1918	12,991	19,099	954	142	30,994
1919	[1] 7,717	26,626	629	1	33,713

VALUE.

1912	$220,583	$1,37	$343,456	.....	$1,586,462
1913	293,756	2,91	391,906	$444	2,011,597
1914	224,118	1,09	277,386	.....	1,444,941
1915	429,631	2,63	52,583	.....	2,618,211
1916	935,471	7,84	96,118	3,187	3,114,060
1917	1,167,879	8,68	349,563	4,444	9,775,860
1918	1,524,254	2,50	121,555	84,712	4,321,237
1919	[1] 743,000	2,96	90,185	137	3,650,774

[1] Preliminary figures, subject to revision.

DOMESTIC EXPORTS.

In spite of the large importations of graphite, both unmanufactured graphite and manufactures of graphite have been steadily exported from the United States. Previous to the war, exports of unmanufactured graphite ranged from 3,000,000 to 4,000,000 pounds annually, averaging (for the four fiscal years preceding the war) 3,931,600 pounds. From 1914 to 1916 there was a considerable increase in the exports of manufactured articles and a marked falling off in the exports of the crude material. But in 1917 the situation was reversed and the export of crude graphite returned to the prewar level while the amount of graphite manufactures decreased about one-third. In 1918 graphite in any form was on the export conservation list, and exports were not permitted except by special license from the War Trade Board.

Graphite crucibles, graphite, and articles manufactured therefrom were removed from the export conservation list, December 6, 1918.

Graphite exported from the United States.

Calendar year.	Domestic unmanufactured.		Foreign unmanufactured.		Domestic manufacture, value.
	Pounds.	Value.	Pounds.	Value.	
1912	4,640,802	$343,456	.....	.....	$177,062
1913	5,351,951	391,906	2,240	$444	238,302
1914	3,920,693	277,386	.....	.....	215,878
1915	1,057,764	52,583	.....	.....	536,572
1916	1,595,608	96,118	248,640	3,187	1,339,269
1917	5,146,816	349,563	35,840	4,444	891,687
1918	1,907,719	121,555	284,480	84,712	731,518
1919	1,258,040	90,185	2,240	137	274,386

ARTIFICIAL GRAPHITE.

Artificial graphite is made by a large company at Niagara Falls, N. Y. The output has increased greatly in recent years and now forms an important element in the country's supply. Bulk graphite is made either from anthracite coal or from petroleum coke. This product, utilized mainly for foundry facings, lubricants, paints, boiler compounds, and battery fillers, enters into direct competition with the amorphous or "dust" grades of natural graphite. The most important use of artificial graphite, however, is in electrodes for electric furnaces, and to the extent that the latter are displacing crucibles this source of graphite may be said to add to the domestic resources. Graphite electrodes are generally made without admixture of natural graphite and are employed in most electric steel furnaces, for the production of aluminum, and in various electrochemical industries. Many of the larger consumers manufacture their own electrodes.

Production of manufactured or artificial graphite. [1]

Year.	Quantity.	Value.	Price per pound
	Pounds.	*Dollars.*	*Cents.*
1900	405,870	32,475	8.0
1901	2,500,000	119,000	4.8
1905	4,595,500	313,979	6.8
1909	6,870,529	467,196	6.8
1910	13,149,000	945,000	7.2
1914	10,455,139	698,800	6.7
1915	[2] 5,580,437	109,102	1.9
1916	[2] 8,922,329	.....	.....
1917	[2] 10,474,649	.....	.....
1918	[2] 9,182,272	.....	.....
1919	[2] 8,163,177	.....	.....

[1] Mineral Industry, 1918.
[2] Powdered graphite only; electrode material not included.

COSTS.

The Tariff Commission has, as yet, made no independent investigation of costs in the graphite industry. But it is known that operating costs in all the domestic mining districts are high. In 1918–19 they are said to range from 6 to 14 cents per pound, with an average of 10 cents per pound of No. 1 flake.[11] In ascertaining costs, the No. 1 flake is charged with the whole operating expense and credited with the income received from the sale of by-product No. 2 flake and dust. In these costs no allowance has been made for depletion and depreciation. Such allowances would perhaps add 1 or 2 cents per pound.

The wide range between the upper and lower limits of domestic costs, as estimated above, reflects differences in efficiency at the

[11] Dub, George D.: Preparation of Crucible Graphite, Bureau of Mines, War Minerals Investigation Series, p. 22.

various plants more than it does varying grades of the ore; although the latter is, of course, a factor. Transportation difficulties, especially in the Alabama field, are also an important feature and serve to raise the costs in that State in spite of the comparative cheapness of mining and crushing the crude material.

Graphite is produced in Alabama from ores that yield as low as 30 pounds of finished product per ton of crude material treated. Of the 30 pounds of graphite recovered, 20 pounds is No. 1 crucible flake and 10 pounds is No. 2 flake and dust products. The cost of production is from 8 to 10 cents per pound of finished product. The freight rate to the Pennsylvania point where the graphite is marketed is 1 cent per pound for carload lots of not less than 30 tons, making the actual minimum cost at point of sale 9 cents per pound.

The following figures are said to represent the cost and market price for the last five years, as applying to the crucible grades only of Alabama graphite:[12]

Year.	Cost per pound.	Market price per pound.
	Cents.	*Cents.*
1914	4	6 to 7
1915	5	7 to 8
1916	6	10 to 13
1917	8	10 to 20
1918	10	11 to 20

It has been testified that in 1918 the Producer's Union of Madagascar offered to furnish the United States annually 15,000 to 20,000 tons of flake graphite at 5 cents per pound f. o. b. Tamatave, for 85 per cent product, with an increase or decrease of $2.91 for each per cent above or below 85 per cent carbon.[13] The freight, brokerage, commissions, etc., would add approximately 1¼ cents per pound to these prices, and the cost of this Madagascar graphite to the American consumer would be between 6 and 7 cents per pound. Although no quotation had been received, at the time, from producers of graphite in Norway, Sweden, Greenland, Spain, and Korea, because their plants were not as yet in operation, their costs, as nearly as could be estimated by H. B. Johnson of the Southwest Graphite Co., of Burnett, Tex., in testimony before the Committee on Ways and Means, September 27, 1919, will not exceed the cost of the Ceylon and Madagascar plants.[14]

[12] A. B. Conklin, secretary of the Graphite Producers' Association of Alabama, before Ways and Means Committee, Sept. 26–27, 1919.

[13] H. B. Johnson, Tariff Hearings, Committee on Ways and Means, Sept. 26–27, 1919.

[14] F. Weed, before Ways and Means Committee, Sept. 26–27. 1919.

At one Madagascar mine producing 25 metric tons of graphite a month, costs in 1918 were estimated at about 225 francs a ton (2 cents a pound). Costs of transportation were estimated at 97.50 to 130.50 francs a ton, and shipping charges and freight to London from 71.50 to 92 francs. Other costs including incidental expenses, stores, taxes, etc., were estimated at 30 francs a ton, and the total cost, c. i. f. London, between £17 and £19 a ton (between 3.8 and 4.2 cents a pound, at normal exchange).[15]

Japanese crucibles made of flake graphite have been sold in Birmingham, Ala., for 10½ cents per unit after paying the import duty of 20 per cent ad valorem and the freight to Birmingham. This is less than the price at which Pennsylvania crucible makers were selling their product f. o. b. factory in 1919.[16]

FOREIGN PRODUCTION.

Ceylon.—Since 1901 the United States has been the largest consumer of Ceylon graphite. In 1917 this country took 81 per cent of the total output. In normal times about two-thirds of the Ceylon product is allowed by the British Government to go to American crucible manufacturers who, because of its peculiar lump form have been willing to pay a much higher price than for any other raw graphite. At the present rate of use it is not improbable that the Ceylon deposits may become exhausted in some twenty years.

Most of the mines are operated by native Singhalese. About 50,000 persons—men, women, and children—are employed in graphite production, which, next to tea, is the most important industry of the island. The work is done almost exclusively by hand, and the care given each tiny fragment of material is only possible in a country where native labor is exceptionally cheap and abundant.

The mining is both by open pit and through vertical shafts, the latter being rarely over 100 feet deep, although a few extend to depths of 400 to 500 feet. Hoisting from even the deeper shafts is done almost wholly by hand, by the use of windlasses. The important deposits are veins consisting almost wholly of graphite. Quartz and pyrite are the only accessory minerals at all common, and they are present generally in minor amounts. The mineral, as it comes to the surface, however, may contain as much as 50 per cent of impurities, owing to the admixture of wall rock.

The impurities are reduced to 5 or 10 per cent by hand picking at the mines, and the crude product is then shipped to the coast. At

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[15] Mineral Resources, 1918.

[16] E. M. Hamil, Tariff Hearings, Committee on Ways and Means, Sept. 26, 1919.

the ports the material is further treated or "cured." This seems to be a strange process, varying in detail at the different "compounds" (yards), but it consists essentially of screening and hand sorting. Women chop up the larger lumps with little hatchets, pick out the coarser impurities by hand, and then polish the pure material with wet burlap. The last operation is the blending of the various grades from several mines in order to meet the requirements of purchasers—a process demanding skill and long experience.

Poorer material is beaten to a powder and sorted. In some places it is washed by hand (the graphite floating off into the tub or pit of water, leaving the heavy impurities in the saucerlike basket used for "panning"). Another process, used for very fine material, is to throw it up in the air. The heavier particles are caught in a basket (shaped like a dustpan), while the graphite is blown forward and falls on the floor.

Madagascar.—This African island probably has the world's most dependable future supplies of flake graphite. The deposits are large, conveniently situated, remarkably rich—containing 50 per cent or more of graphite—and are capable of greatly increased production. From 1914 to 1917 the output trebled. Anticipating the decline in production from Ceylon, British crucible makers as well as the French now obtain most of their graphite supplies from Madagascar. Madagascar plumbago is of increasing importance in the United States; the Madagascar flake is more like the domestic flake than is the Ceylon lump.[17]

The commercial production of graphite in Madagascar, which began in 1909, had reached an output of 70,000,000 pounds in 1918. The decrease in demand in 1919 for the lower grades of graphite has caused the Madagascar producers to improve the quality of their product. Recent analyses at Tamatave show 87 to 90 per cent carbon, and even 93 to 95 per cent is reported by some companies in contrast to an average of 80 to 82 per cent in 1916–17. Most of the small mines have been closed and the large ones have curtailed their production greatly. It seems probable that from present information the 1919 production will not exceed 12,000,000 pounds.[18]

As there are no refining mills in Madagascar, graphite is shipped practically as it is mined. From statistics available it would seem that but one shipment was made in the first six months of 1919. This was 28 tons to France.[18]

In July, 1919, it was estimated that the following stocks were held by producers and exporters in Madagascar.[18]

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[17] Madagascar deposits and methods of mining are described in detail by Bastin (Mineral Resources, 1913, Vol. II).

[18] Monthly report of investigations—Bureau of Mines, November, 1919.

Grade (per cent carbon):	Pounds.
78–80	11,000,000
80–83	16,500,000
83–87	16,500,000
87–90	6,600,000
Above 90	4,400,000
Total	55,000,000

Austria.—In normal times Austria has been the largest producer of graphite as regards quantity. The producing districts in order of importance are Bohemia, Styria, Moravia, and lower Austria. The product, however, is almost exclusively of the amorphous variety. Before the war a large part of the output was exported chiefly for making pencils. Overproduction has made it possible at times to buy the Austrian product in the United States below cost.

Germany (*Bavaria*).—The German supply of graphite comes from Passau near the Austrian frontier, is of the flake variety, and found in decomposed schist. It was formerly used largely in the manufacture of crucibles, but before the war German crucible manufacturers used a large amount of Ceylon graphite. The decrease of the German metal business has greatly lessened the demand for crucibles. This, combined with an overproduction and the competition of the cheaper graphite from Madagascar and Ceylon, has caused a serious crisis in the Bavarian graphite industry.

Other countries.—Since the exclusion of Austria from outside markets, Mexico, Chosen, and Italy have been the principal sources of amorphous graphite. The Mexican product is of excellent grade and is available in large amounts. The largest productive deposit is owned by a graphite company in Saginaw, Mich. (who ship the crude ore from Mexico to Michigan for separation). American capital is interested in most of the other Mexican producing properties and also in Canada and Chosen (Korea). The product of the latter country, however (consisting largely of amorphous but with some flake), has been largely shipped to England during the war period. The Canadian flake is similar to the American, but most of the properties produce only one-half as much flake as dust. About 25 per cent of the product is large flake, and a large part of the remainder must be sold at a reduced price as "foundry plumbago."

Italy has become a less important producer of amorphous graphite since the war. The American market has been lost, so the product is largely exported to England and France.

Aside from the above-mentioned countries, though graphite deposits have been opened in various parts of the world, none has become of more than local importance. Roumania and Japan appear to have promising deposits of flake material that may enter the world market.

World's production of natural graphite, 1914–1918.

[In short tons.]

Country.	1914		1915		1916		1917		1918	
	Quantity.	Value.	Quantity.	Value.	Quantity.	Value.	Quantity.	Value	Quantity.	Value.
United States [1]	4,333	$324,118	4,717	$429,631	8,082	$935,471	13,590	$1,167,879	12,988	$1,524,254
Canada [1]	1,648	107,203	2,636	124,233	3,955	325,362	4,048	402,892	3,115	248,970
Mexico [2]	4,260	190,075	1,681	75,000	5,325	238,000	7,572	285,568	5,600	134,183
Italy	9,443	50,051	6,808	40,100	9,019	58,349	13,357	141,900	.....	.....
Spain [3]	.....	.....	36	30	1,367	1,540	2,183	984	.....	.....
Sweden	62	4,140	96	6,432	214	17,956	4	32	.....	.....
Ceylon [3]	15,943	1,142,000	24,441	2,569,434	37,430	7,298,128	30,393	7,071,803	17,307	[4]2,685,000
India	.....	.....	78	769	1,681	7,344	116	2,660	.....	.....
Japan	[4]632	156,000	[4]734	15,000	1,261	25,903	1,308	.....	.....	.....
Chosen (Korea)	12,125		7,767	101,041	18,682	243,000	7,165	.....	.....	.....
Madagascar	8,542	688,720	13,063	1,053,250	28,087	2,213,000	38,581	3,040,000	17,637	[4]1,391,000
South Africa	34	2,977	41	5,856	61	8,657	86	12,596	.....	.....
Australia	37	4,718	77	144	.....	.....	78	97	.....	.....

[1] Sales at mines.
[2] Exports.
[3] Figures obtained from Spanish Consular Reports.
[4] Estimated.

Austria: No data. Production in 1913, 54,515 short tons valued at $417,745.
France: No data. Production in 1913, 1,316 short tons valued at $3,320.
Germany: No data. Production in 1913, 13,293 short tons valued at $63,308.

IMPORTS.

Both amorphous and flake graphite are imported. Prior to 1918 the imports of graphite ranged from six to ten times the domestic output. In 1918 imports reached the minimum ratio of one and one-half times the domestic production, but in 1919, with the removal of war-time restrictions, they increased to more than three times the domestic production. The principal source of imported graphite is the island of Ceylon. Approximately 90 per cent of this Ceylon material has been used in the manufacture of crucibles. Amorphous graphite, formerly imported in large amounts from Korea (partly via Japan), has been replaced by similar material obtained from Mexico. Before the war the Mexican product was imported chiefly for making pencils.

The import statistics show the effects of war conditions and the rearrangement of trade routes. The later increase of imports from France are wholly of Madagascar origin, while the graphite attributed to Great Britain had its origin in Ceylon. Since the imports credited to Canada in 1914 and 1915 were in excess of the Canadian production in those years, it is probable [20] that they include a certain amount of Ceylon graphite.

The Ceylon product is imported largely for its special qualities. Its lump form, purity, and the unusual care given to its grading and blending make it especially suitable for making crucibles. Much

[20] Ferguson: Mineral Resources, 1917, U. S. Geological Survey.

of the Madagascar product needs to be refined after arriving in this country. Madagascar flake is not as satisfactory as the Ceylon material and competes with domestic flake chiefly because of its lower price. Among amorphous graphite imports, the Mexican graphite is preferred for pencil making to similar grades produced in the United States. Imports from Korea and certain European countries are strictly competitive with the domestic product. Austrian and other European graphite imports normally can not be sold here in competition with the cheap Korean (Chosen) and Mexican supplies and, even before the war, had practically disappeared from the American market.

Graphite imported for consumption into the United States.

Calendar year.	Quantity.	Value.	Calendar year.	Quantity.	Value.
	Short tons.			*Short tons.*	
1907 [1]	22,939	$1,777,389	1914	21,990	$1,398,209
1908 [1]	11,456	762,367	1915	23,075	2,241,163
1909 [1]	21,267	1,854,459	1916	42,930	7,279,884
1910	25,305	1,872,592	1917	42 577	8,961,988
1911	20,701	1,495,729	1918	19,099	2,983,250
1912	25,642	1,709,337	1919	26,626	2,978,096
1913	28,880	2,109,791			

[1] Figures from Mineral Industry.

Graphite imported into the United States, by countries.

[Calendar years.]

SHORT TONS.

Country of origin.	1913	1914	1915	1916	1917	1918	1919
Ceylon	16,996	8,882	14,491	26,232	24,575	9,029	17,963
Madagascar	.....	349	1,468	1,631	4,393	970	1,504
Canada	1,662	1,806	2,995	4,127	3,476	8,084	1,504
Brazil	.....	.....	.....	1	18	45	1
Mexico	4,435	4,259	1,680	5,331	7,570	5,600	5,506
Japan and Korea	4,170	6,327	2,373	5,375	2,462	568	110
Italy	236	254	27	151	115	17	22
Austria	660	78	.....	.....	.....	.....	.....
Other countries	720	47	41	169	.....	185	.....
Total	28,879	22,002	23,075	43,017	42,609	19,498	26,610

VALUE.

Ceylon	$1,674,764	$972,408	$1,826,238	$6,356,532	$7,179,208	$2,397,735	$2,580,281
Madagascar	.....	38,704	184,067	241,863	1,057,081	265,338	305,350
Canada	98,665	92,536	116,407	314,177	349,034	236,226	102,163
Brazil	.....	.....	.....	75	4,380	7,351	217
Mexico	198,000	190,075	75,000	238,000	285,568	134,183	135,464
Japan and Korea	58,199	96,433	35,292	103,619	83,558	24,456	3,211
Italy	4,061	3,203	994	4,133	3,092	628	683
Austria	9,957	1,258	.....	.....	.....	.....	.....
All other countries	66,145	3,644	3,165	21,484	67	26,559	.....
Total	2,109,791	1,398,261	2,241,163	7,279,883	8,961,988	3,092,475	2,977,349

Graphite imported into the United States, by countries—Continued.

[Calendar years.]

VALUE PER TON AND PERCENTAGE OF TONNAGE, TO WHOLE AMOUNT IMPORTED.

Country of origin.	1913		1914		1915		1916	
	Value.	Per cent.	Value.	Per cent.	Value.	Per cent.	Value.	Per cent.
Ceylon	$79.54	58.85	$109.50	40.37	$126.03	62.80	$242.32	60.98
Madagascar	.....	.....	110.90	1.59	125.38	6.36	148.30	3.79
Canada	59.40	5.76	51.24	8.21	38.87	12.98	76.13	9.60
Brazil	.....	.....	.....	.....	.....	.....	75.00	.....
Mexico	44.64	15.36	44.63	19.36	44.64	7.28	44.64	12.39
Japan and Korea	13.96	14.44	15.24	28.76	14.87	10.28	19.28	12.50
Italy	17.21	.82	12.61	1.15	36.86	.12	27.37	.35
Austria	15.09	2.28	16.13	.35	.....	.....	.....	.....
Other countries	91.86	2.49	77.53	.21	77.20	.18	127.12	.39
Total	.....	100.00	.....	100.00	.....	100.00	.....	100.00

Country of origin.	1917		1918		1919	
	Value.	Per cent.	Value.	Per cent.	Value.	Per cent.
Ceylon	$292.13	57.68	$265.56	46.31	$140.86	67.51
Madagascar	240.63	10.31	273.54	4.97	136.54	5.65
Canada	100.41	8.16	76.60	15.82	67.93	5.65
Brazil	243.33	.04	163.35	.23	217.00	.....
Mexico	37.72	17.78	23.96	28.72	24.60	20.69
Japan and Korea	33.94	5.78	43.05	2.91	29.19	.42
Italy	26.89	.27	37.00	.09	30.14	.08
Austria	.....	.....	.....	.....	.....	.....
Other countries	.....	.....	143.56	.95	.....	.....
Total	.....	100.00	.....	100.00	.....	100.00

PRICES.

On account of its qualities and reputation, Ceylon graphite has always commanded the highest price of all grades, and since the difficulty of shipment, due to war conditions, its prices have been relatively higher in comparison with other kinds of flake. The average price before the war was 10 cents per pound for lump, 6 cents for chip, and 4 cents for dust. There was a sharp increase in 1913 (about 30 per cent), ue chiefly to severe floods on the island and to increased mining cost, but in 1914 prices returned to about the normal level. In 1915 prices of Ceylon flake rose very rapidly. On account of the submarine menace in the Mediterranean, shipments could no longer go by way of the Suez Canal and had to round the Cape of Good Hope. The freight increased first to three times and later to nearly six times its former level. The highest prices of Ceylon flake reached during the war were 30 cents a pound for lump, 22 cents for chip, and 14 cents for dust. In spite of the embargoes placed upon the material there was at no time any great shortage of the Ceylon material, and the policy of the War Industries Board in ordering the substitution of a certain amount of domestic flake for overseas product in making crucibles resulted in a conservation of stocks. In January, 1919, lump was quoted at 18 cents, chip 14 cents, and dust 11 cents

per pound. (All these prices are f. o. b. New York and include excess freight charges and war-risk insurance.) But in June (1919) the best grades of Ceylon were quoted at 12¼ to 12¾ cents per pound; other grades were nominal.

Prices of imported Ceylon for crucible manufacture.

[Average prices in cents per pound paid by crucible makers.]

Kinds or grades.	1911 [1]	1912 [1]	1913 [1]	1914 [1]	1915 [2]	1916 [3]	1917 [4]	1918 [5]
Ordinary lump (approximately 90 per cent graphitic carbon):								
Best	8½–9	8½–10	9½–11	8½–10½	9 –22	26 –28	28–30	18
Medium	7 –8	7 – 8	7½– 9	7 – 9	7½–15	.....	.....	.....
Poor	6 –7	5½– 7	6½– 8	6 – 8	6 –12	.....	.....	.....
Chip (approximately 80 per cent graphitic carbon):								
Best	5½–5¾	5½– 7	7½–10	7 – 9	7 –15	19 –20	19–21	14
Medium	4 –5	4½– 6	6½– 8½	6 – 8	6 –13	.....	.....	.....
Poor	3½–4	3½– 4½	4 – 7	4 – 7	5 –10	.....	.....	.....
Dust (approximately 70 per cent graphitic carbon):								
Best	3½–4	3 – 3½	4 – 5½	4 – 5½	5 – 7½	10½–12	11–12	11
Medium	2¾–3½	2½– 2¾	3 – 4	3 – 4	4 – 6	.....	.....	.....
Poor	2 –2½	1½– 2½	2 – 3	2 – 3	3 – 6	.....	.....	.....
Flying dust:								
Best	3½–3½	2 – 2½	2½– 3½	2½– 3½	3 – 5	(6)	(6)	(6)
Medium	2 –2½	1½– 2	2 – 3	2 – 3	2½– 4	.....	.....	.....
Poor	1½	1½– 1½	1½– 2	1½– 2	2 – 3	.....	.....	.....

[1] Mineral Resources, U. S. Geological Survey.
[2] In general, the lower figure is the price in January and the higher that for December. Prices rose quite steadily throughout the year.
[3] From Mineral Industry. Prices fairly steady.
[4] March quotation, ex-dock New York. Similar quotations with few sales continued into 1918.
[5] Quotations at end of year.
[6] No longer on market.

The average price of plumbago f. o. b. ship from Ceylon in 1918 was $103 per ton, or 5.15 cents per pound (Ceylon Blue Book, 1918), as compared with $85 per ton, or 4.25 cents per pound for the first six months of 1919 (taken from Ceylon customs returns June, 1919. p. 117). Department of Commerce Reports of November 4, 1919, show prices of August 27, 1919, to be for Ceylon lump, $85 to $175 per ton; Ceylon chips, $65 to $105 per ton; Ceylon dust, $25 to $55 per ton: flying dust as low as $15 per ton. Prices quoted by Engineering and Mining Journal, December 10, 1919, are: Ceylon lump, 15 to 16 cents per pound; Ceylon chip, 11 to 12 cents per pound; Ceylon dust, 8–9 cents per pound. The increase has been due to the increased premium on rupee exchange and high freight rates.

There have been until recently no regular quotations for other grades of graphite. Madagascar, domestic, and other material were sold on the basis of supply and demand for the individual product, although the general market exhibits the same tendencies as the Ceylon market. The Engineering and Mining Journal quoted on July 17, 1920:

Crucible flake, 85 per cent carbon content, 8 cents per pound; 88 per cent, 9½ cents; 90 per cent, 10½ cents; all f. o. b. New York; 80 per cent, 5 cents; 90 per cent, 10 cents; 30 per cent (dust polish grade), 1 cent; 50 per cent (dust facing grade), 2 cents; f. o. b. Ashland, Alabama; Mexican, amorphous, $45 to $55 per short ton; Korean, 3¼ cents per pound; Madagascar, 8 cents; Ceylon, 4¾ to 15½ cents.

It is reported that large tonnages of Madagascar were offered in April, 1919, at 7 cents New York, but with few sales.

Prices quoted July, 1919, for 90 per cent carbon material f. o. b. ship, Madagascar, averaged 550 francs per metric ton, or $0.048 per pound at the normal rate of exchange ($1 = 5.181 francs), with an increase or reduction of 15 francs ($2.90) for each per cent above or below the base.

Average annual prices for several grades of domestic and foreign material for the domestic market are tabulated below:

Prices of natural domestic graphite.

[Cents per pound f. o. b. mines.[1]]

Year.	No. 1 flake.	No. 2 flake.	Inferior flake.	Dust.	Amorphous.	Miscellaneous.[2]
1910	6 - 8½			½–2	2½–3½	
1911	6 - 7	4 - 6	2½– 4	½–2½		1½ (Mexican amorphous), 1.3–1.275 (Chosen).
1912	6 - 7	4 - 6½	2½– 4	¾–3		1.25 (Chosen).
1913	6 - 8					1–1½ (Chosen).
1914	6½– 8					4–6 (Mexican), a few grades 8, 5–7.5 (Madagascar), 1½ (Chosen).
1915	7 –10					6 to 11-12 Madagascar, 4–4.5 (Mexican), 1.25–2.5 (Chosen).
1916	10 –16					
1917	12 –18	9½–12	6 –10	½–5		
1918	16 –17¾	10 –13	7 –10	(3)		

[1] From data collected by U. S. Geological Survey.
[2] At New York.
[3] 25 to 30 per cent, 1 cent per pound; 85 to 90 per cent, 12 cents per pound.

Schedule of prices adopted by the Graphite Producers' Association of Alabama.[1]

Grade.	Per cent carbon.	Price per pound.
		Cents.
No. 1 flake	90	[2] 20½
No. 2 flake	85	[3] 15½
No. 3 flake	80	10

Per cent carbon.	Price per pound.	Per cent carbon.	Price per pound.
	Cents.		*Cents.*
25 to 30	1	60 to 65	4½
30 to 35	1½	65 to 70	5½
35 to 40	1½	70 to 75	6½
40 to 45	2	75 to 80	7½
45 to 50	3	80 to 85	10
50 to 55	3½	85 to 90	12
55 to 60	4		

[1] Mineral Industry, 1918. Eng. Min. Jl., vol. 107, No. 194 (1919).
[2] With 1 cent added per pound for each per cent above 85 per cent.
[3] With one-half cent added per pound for each per cent above 80 per cent.

Valuation of all grades of foreign graphite.

[Valuation of domestic natural and artificial graphite in cents per pound.]

Year.	Ceylon.[1]	Madagascar.[1]	Chosen.[1]	Mexico.[1]	Canada.[1]	Domestic.[2]	Artificial.[3]
1910	.....	.....	.....	.....	.....	4.90	7.19
1911	4.30	.....	0.74	3.80	1.70	5.30	6.54
1912	4.10	.....	.70	2.30	2.30	5.30	6.44
1913	4.90	.....	.70	2.20	3.00	5.00	7.14
1914	5.50	5.50	.76	2.20	2.60	5.50	6.65
1915	6.30	6.30	.74	2.20	1.90	5.90	[2] 1.95
1916	[4] 12.00	7.40	.85	2.20	3.80	8.40	.....
1917	14.60	12.00	1.70	1.90	5.00	10.30	.....
1918	13.20	13.60	[5] 2.15	1.20	3.80	11.30	.....
1919	7.18	6.83	[5] 1.46	1.23	3.40	5.18	.....

[1] Calculated from import valuations calendar year totals of all classes of graphite.
[2] Mineral Resources.
[3] From Mineral Industry. Prices previous to 1915 include electrodes; for 1915 and later, powdered graphite only.
[4] Increase due partly to larger percentage of better grades.
[5] Includes Japan.

COMPETITIVE CONDITIONS.

CRYSTALLINE GRAPHITE.

In normal times the domestic graphite-mining industry is not in a position to compete successfully with unrestricted imports from Madagascar and Ceylon. The domestic product costs more and must be sold at a lower price. In both Ceylon and Madagascar the deposits are of large extent and so free from impurities that comparatively little treatment or refining is necessary. Most of the domestic flake as found disseminated in low-grade deposits requires comparatively complicated machinery and processes to prepare it for market. It has the further disadvantage of being thinner. The Ceylon graphite especially has had some technical and much popular reputation as being more desirable for making crucibles. At present Alabama flake producers contend, and are seeking to establish, that war experiments have shown that such a reputation and its resulting differential in prices are unwarranted, so far as their product is concerned.

In the Far East labor is much cheaper than in the United States and, by virtue of the natural advantages of the deposits, there is no difficulty in producing in quantity.

In spite of the great distance from the American market, graphite from these islands has been sold continually in the United States at prices that allowed no profit to domestic producers. Before the war the highest grade of Ceylon graphite was sold in New York at less than 10 cents a pound, as against a maximum of about 8 cents for domestic flake. The gradual exhaustion of the deposits and the increasing cost of production in Ceylon are more than offset as far as the domestic market is concerned, by the rapid development of Madagascar deposits. Canada is the only other country from which flake graphite is imported, but the amount is too small to exert any

marked influence on the domestic market and its quality is similar to that of the American product.

Many of the Alabama plants are situated 6 to 9 miles from railroads and in a region where wagon roads (clay) are difficult to maintain. For certain companies, therefore, the transportation problem is serious. But the gravest handicap is the universally low grade of the deposits. Even if a price of 10 cents per pound can be obtained for No. 1 flake—nearly 50 per cent higher than before the war—only the most efficient plants will be able to survive. Improvements in treatment of ore and refining of the product are strengthening the position of the producers, and the possible establishment of plants for the manufacture of finished graphite products close to the mines and the consequent ready sale of by-products (No. 2 flake and dust) would be of even more assistance; but it is by no means probable that the industry can maintain itself against the competition of the foreign producers who have better natural resources and lower priced labor.

Costs of New York and Pennsylvania producers are reported to be practically the same as to those of Alabama, chiefly because most plants have just begun producing; but for the future the industry in these States has a distinct advantage over the Alabama production because of the better grade of the deposits and greater ease of access. The slight advantage of underground mining as compared with methods of the southeastern section is a minor factor. The Texas industry is favored by nature to an even greater degree. Its main handicap is the lack of outlet for by-product grades of flake.

The following statements made by Dub [21] reflect the status of the flake mining industry in this country:

> For domestic flake graphite the supply exists and can be obtained. If the demand can be created and extended by scientific rather than by artificial means, the supply will be forthcoming whenever the price is high enough to justify production.
>
> With the resumption of peace-time activities the demand for crucibles and other graphite products will probably slacken. This will, of course, react upon the domestic graphite mining industry. To be independent of foreign graphite, the use of 100 per cent domestic flake in crucibles will have to be developed if the graphite crucible continues as a medium for melting alloys of all kinds. It is possible, of course, that the use of some refractory other than graphite, or the extended use of melting furnaces requiring no crucibles may develop to such a point as to make present practice obsolete.

The average carbon content of domestic graphite deposits will not exceed 5 per cent. The average percentage of carbon in the Ceylon ore may be as much as 50 per cent, while the Madagascar graphite runs from 30 per cent carbon in ore from the plateau section to 60 per cent carbon for the lowland district.[22] The average carbon con-

[21] Dub, Geo. D.: Preparation of Crucible Graphite, Bureau of Mines, War Minerals Investigation.
[22] U. S. Geological Survey, Graphite in 1918.

tent of the graphite bodies of Norway, Sweden, Greenland, Spain, and Korea is reported as 20 per cent.[23]

Brass and steel manufacturers are changing their practice in the use of graphite crucibles by substituting electric furnaces for graphite crucible fusions. In the nonferrous metal industries the year 1919 was characterized by a wide-spread introduction of electric melting furnaces in place of melting in crucibles or open combustion furnaces. Fifty or more electric furnaces were erected in a single brass-making city (Bridgeport, Conn.) and the other brass makers in the country are either looking on with interest or already determined to follow suit. It is possible that the crucible may eventually be eliminated from the brass industry. The growth of the electric process of steel making during the last few years has resulted in the abandonment of crucible methods in the steel industry also. Crucible manufacturers state that if a duty is placed on crude graphite the crucible business will be placed at a further disadvantage in competition with other methods of melting metals.

AMORPHOUS GRAPHITE.

The production of natural amorphous graphite has never been an important industry in the United States. It has to meet the competition not only from foreign producers but also from the by-products of flake mining, as well as the more serious production of artificial graphite. There was little stimulus given this production during the war, and its after-war problems are no more complicated than were the prewar conditions. Both Chosen and Mexico have larger and higher grade deposits, but are handicapped by their greater distance from the market. In the case of this relatively cheap commodity transportation charges are a more important factor than in the case of the more costly crystalline grades.

ARTIFICIAL GRAPHITE.

Artificial graphite and graphitized carbon manufactures require mention, since they are competitive with natural grades. The American industry is large, important, and highly integrated. In view of the comparatively low value of the product, the acquired skill required in the manufacture, and the enterprise of its management, it is apparently proof against foreign competition in the American market and is reaching out into the export field.

TARIFF HISTORY.

Graphite has been on the free list under the name of plumbago since 1872. From 1846 to 1872 there was a duty ranging from 20 per cent to $10 per ton on the article as "plumbago or black lead."

[23] H. B. Johnson, Tariff Hearings, Sept. 26-27, 1919.

COURT AND TREASURY DECISIONS.

An article of earth, slate, and shale, together with plumbago or black lead was held dutiable as a "mineral and bituminous substance in a crude state, n. s. p. f." at 20 per cent ad valorem under section 20 of the act of March 2, 1861, unless "approximating in value to plumbago," in which case it was classified as plumbago at $10 per ton under section 8 of the act of July 14, 1862, by virtue of section 20 of the act of August 30, 1842. (Dept. Order (1870), T. D. 691.)

Powdered plumbago, although having undergone a process of refinement for removal of iron, lime, or other foreign substances present in the crude article as taken from the mines, was held to be plumbago within section 5 of the act of June 6, 1872, and accordingly exempt from duty. (Dept. Order (1873), T. D. 1627.) But blocks of plumbago with other ingredients were held dutiable at 20 per cent as an unenumerated manufacture and not exempt from duty as plumbago. (Dept. Order (1874), T. D. 1947.)

So-called old broken crucible shells, parts of crucibles, composed chiefly of plumbago and imported for the purpose of recovering the plumbago, were held not exempt from duty as plumbago under paragraph 579 of the act of 1913, but dutiable as waste, n. s. p. f., under paragraph 384. (Dec. Treas. Dept., Apr. 18, 1918.)

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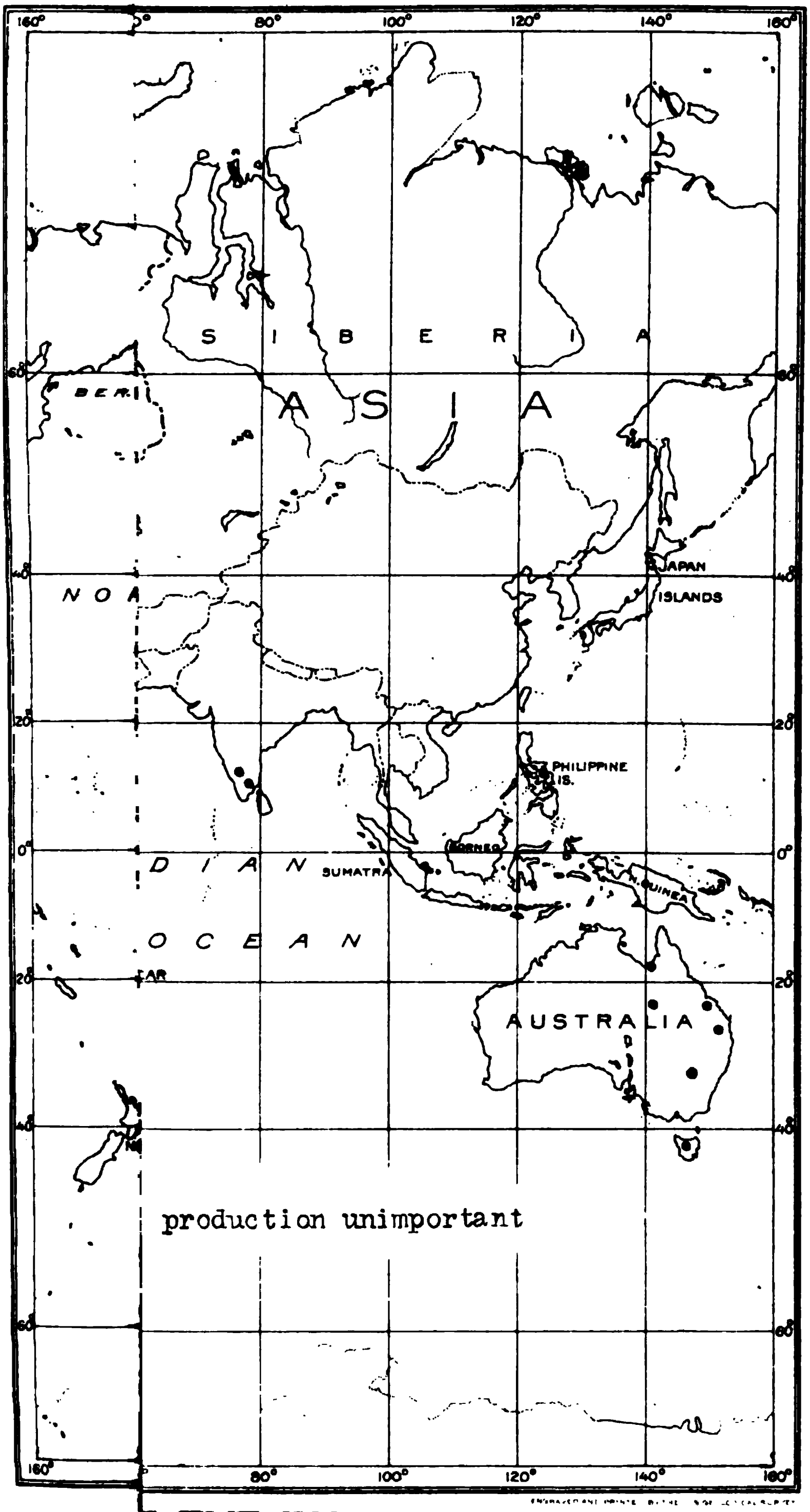
MAGNESITE



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MAGNESITE.

SUMMARY.

IMPORTANCE OF THE INDUSTRY.

The essential use of magnesite is in metallurgy, as a refractory material for lining open-hearth steel furnaces; welding, heating and melting furnaces; reverberatories; settlers and furnaces for refining lead; copper converters; and electrical furnaces. There is no satisfactory substitute for magnesite brick, but dolomite, slag, or Canadian high-lime magnesite are being used as substitutes for magnesite grain.[1]

The use of magnesite extends into industries manufacturing Sorel cement, sanitary flooring, wall plaster, wood-pulp paper, fire-resisting paint, heat-insulating material, chemical salts and metallic magnesium. These same products, however, can be made from other magnesian rocks, such as dolomite, and are frequently so prepared.

FOREIGN AND DOMESTIC RESOURCES.

United States magnesite resources are substantial, conservative estimates placing known reserves at 8,000,000 tons. The enormous deposits of Austria-Hungary with over 120,000,000 tons in reserve, have long been the main supply for the world's requirements. The magnesite of Austria has just the right proportion of iron in its composition to give a desired bonding action. None of the American material, so far discovered, contains quite the requisite amount of iron, although the Washington deposits approximate the Austrian material, and with the addition of small amounts of iron are proving a satisfactory substitute.

DOMESTIC SUPPLIES.

The magnesite business has expanded from an insignificant pre-war status to a capacity amply sufficient for this country's requirements, 95 per cent of which were formerly satisfied from the Teutonic nations. Two companies operating in the State of Washington, and some seven smaller plants in California, left from a former two dozen, contributed to the 162,000 tons produced in 1919.

FUTURE COMPETITIVE CONDITIONS.

The magnesite industry is threatened by severe competition within the country as well as from without. There sprang up as a war

[1] Material for furnace bottoms.

development the use of burnt dolomite among eastern metallurgical plants. This has made great inroads into the former market for magnesite. A half dozen plants east of the Mississippi are turning out a dolomite refractory which, with the magnesite of Washington, has been entirely replacing the former importation of Austrian magnesite, although Canadian magnesite still enters.

With the free importation of magnesite, Canadian, Grecian, and Austrian material will probably supply the eastern United States market. A western prewar market existed for a small amount of magnesite in the manufacture of plaster, paper, flooring and refractory material, and this demand will continue to be met by California and Washington producers.

The magnesite business requires costly mechanical equipment. Two large modern plants have been installed in Washington. When the armistice was signed the Washington and California investments had brought the industry to a point where the production of high grade magnesite was about to allow the return of a reasonable profit at then existing prices. The present producers of American magnesite maintain that if they can continue for two or three years, experience will enable them both to improve the standard which Austrian magnesite had established, and to lower their own costs by large operations and technical progress.

THE MAGNESITE INDUSTRY.

Tariff act of 1913, paragraph 539:

"Magnesite, crude or calcined, not purified," free.

MARKET GRADES AND USES.

Magnesite is marketed either (1) crude or (2) calcined. Crude magnesite is the material as mined except that it may be sorted or undergo a simple cleaning operation to remove admixed rock waste. A very small use of the crude material is as a substitute for barite in paint manufacture. Some is made into magnesium salts; but practically all the product is calcined; yielding, according to the temperature, either caustic or dead-burned magnesia.

(*a*) *Caustic magnesia* (moderate temperatures) is magnesite from which most of the carbon dioxide is driven off, but from 3 to 8 per cent is intentionally left in the residue. In this form the residual magnesia combines readily with water and carbon dioxide in the air (compare quicklime) and with various acids for the manufacture of salts. Mixed with magnesium chloride (which may be made from magnesite and muriatic acid, but which is generally derived as a by-product in salt manufacture), caustic magnesia is made into Sorel ("oxychloride") cement. This mixture, generally modified by the addition of various filler materials (wood flour, cork, talc, silica, asbestos, clay, marble, dust, sand, etc.) together with suitable coloring matter is sold under various trade names. It is one of the best floorings. The use of magnesite cement in floors and as stucco and wall or outside plaster is gaining importance. It sets much quicker than Portland cement and has the peculiar advantage of great resiliency. As the determining factor in ordinary floors is the deflection under load, the large deflections possible with this material permit lighter and cheaper building frame construction. Calcined magnesia is also used in making magnesium bisulphite for disintegrating wood pulp in paper making. It is highly probable that the consumption of caustic magnesia—now estimated at 40,000 to 50,000 tons per year—will grow to a tonnage equal to that of the refractory or dead-burned magnesia. The utility of caustic magnesia in the building and flooring trades is expanding.

(*b*) *Dead-burned magnesia* (heated to incipient fusion) is magnesite from which the last traces of carbon dioxide have been removed. In this state, it will not slake or combine with chemicals. It is largely used for basic open-hearth steel furnaces, converters, and kilns for

sulphuric acid (pyrites) burning, and in electric furnaces. Dead-burned magnesia comes in the form of brick and grains.

The principal use of magnesite is in the making of refractory brick, in general use throughout the world in the linings of metallurgical furnaces wherein the smelting and refining of steel, copper, lead, and other metals is carried on. For this particular purpose there are no entirely satisfactory substitutes, and only the highest quality of magnesite itself can be used for certain parts of the work.

(*c*) *Carbon dioxide* may be saved, but only when caustic product is to be made. The character of the calcination for the production of dead-burned magnesite is not suited to the recovery of gas.

(*d*) *Metallic magnesium, magnesium oxide and salts* are rarely made from magnesite. In most cases a supply of by-product magnesium chloride is more cheaply available and the use of magnesite for these purposes is exceptional. Magnesia for chemical and medicinal use, as well as pipe covering material, light carbonate and other products come in this class.

SUBSTITUTES.

High magnesian dolomite is a material that has proved to be a fairly satisfactory substitute for magnesite in many classes of metallurgical work. In 1913, 178,530 tons of calcined magnesite were consumed in the United States; in 1917, 177,524 tons. Steel manufacturers substituted dolomite for magnesite in a large part of the war installations. Dolomite is much cheaper and far more widely distributed than magnesite, but is not so refractory. Slight changes (high lime slags) in furnace processes are often necessary in using this material. The first successful bottoms used in the basic open-hearth steel furnaces were made of burned dolomite, rammed in with tar, but new bottoms of dead-burned magnesite, later installed, gave much better results.[2] Dolomite is now used to the extent of 40 to 70 pounds per ton of steel, as patching material at the slag line and other parts of the furnace bottom that become eroded. Magnesite is used in making up new bottoms and for patching big holes that may wear at bottom and at critical points of the furnace. Dolomite, on account of its cheapness and the satisfactory results obtained, will always have a considerable use for patching in preference to magnesite where an inferior refractory material will answer. Bauxite is another basic refractory material and may take the place of magnesite in certain classes of metallurgical work. Patented products consisting of dolomite treated with furnace dust and roasted "kendymag," "syndolag," and "magnibrent"—have come into more or less satisfactory use at steel plants.

[2] Carnegie Steel Co.

TARIFF CLASSIFICATIONS.

Both caustic and dead-burned magnesite are included as "calcined" not purified and are classed with crude magnesite under paragraph 539 on the free list (act of 1913). Magnesite brick (par. 71) differs from dead-burned magnesite only in having been molded into definite forms subsequent to calcination.

In the chemical schedule (par. 42) "magnesia: Calcined and carbonate of, precipitated" are listed as dutiable, while conceivably these products accord closely in chemical composition with calcined and crude magnesite. The intent of the act is clear in that they are (generally purer) products produced by chemical processes from magnesium salts, especially those from Stassfurt, Germany.

DOMESTIC PRODUCTION.

The maximum domestic production of magnesite was in 1917 when the total output amounted to 316,838 short tons and was valued at $2,899,818 at the mines. The 1918 production was on a somewhat reduced scale due to competition from Canada, and a more general use of substitutes (notably burned dolomite in some of the eastern metallurgical plants and even in the paper trade).

Relation of domestic production to domestic consumption.

Calendar year.	Domestic production.	Imports for consumption.[1]	Ratio of imports to domestic production.	Value (imports for consumption).[1]	Value per unit of quantity.[2]
	Short tons.	*Short tons.*	*Per cent.*		
1910	12,443	323,654	2,610	$1,542,800.00	$6.23
1911	9,375	257,124	2,743	1,185,867.00	5.86
1912	10,512	268,409	2,553	1,369,665.00	5.83
1913	9,632	347,428	3,607	1,757,476.00	6.41
1914	11,293	256,988	2,276	1,377,871.00	4.10
1915	30,499	102,913	337	487,211.00	5.12
1916	154,974	93,885	61	838,630.00	8.42
1917	316,838	38,208	12	464,706.00	7.67
1918	231,605	44,125	19	927,255.00	14.86
1919	162,000	25,322	16	374,032.00	16.19

[1] Quantity of imports of calcined have been doubled (assuming a 50 per cent loss in weight because of the calcining operation) and added to quantity of crude. Values of calcined simply added to those of crude in this table.
[2] Based on imports of crude only.
Domestic exports, none.

The calcining capacity of the California plants is estimated at 20,000 tons per month. In Washington, considering one plant alone, there is a calcining capacity of 10,000 tons per month, making the present available capacity of the country in excess of 20,000 tons per month, or 240,000 tons per year, which is more than ample for our requirements.[3]

The total investment in California and Washington, in the magnesite industry, is estimated [3] as from $3,500,000 to $4,000,000,

[3] W. C. Phalen, Min. & Sci. Press, Aug. 30, 1919.

with the normal employment of 1,000 to 1,500 men in the producing and transporting ends of the business. In tariff hearings before the Committee on Ways and Means a witness for the American Refractories Co. estimates that this investment has not exceeded $500,000.[4]

Magnesite has been produced in the United States since 1891. Prior to the outbreak of the European war, California was the only producing State. The total output, averaging about 10,000 tons, was consumed locally, chiefly in the manufacture of paper. In 1913 and 1914 a small amount was taken by makers of stucco and Sorel cement, especially for use in the buildings of the Panama Pacific Exposition.

The first magnesite produced in the State of Washington was 715 tons mined in December, 1916. In 1917 the State yielded 105,000 tons and in 1918 147,528 tons, an output nearly twice as large as that of California. The 1919 production is estimated as 120,000 short tons.[5]

Production in United States.[1]

[From Mineral Resources, U. S. Geological Survey.]

Year.	Quantity (short tons).	Value.	Year.	Quantity (short tons).	Value.
1900	2,252	$19,333	1913	9,632	$77,056
1904	2,850	9,298	1914	11,293	124,223
1909	9,465	37,860	1915	30,499	274,491
1910	12,443	74,658	1916	154,974	1,393,693
1911	9,375	75,000	1917	316,838	2,899,818
1912	10,512	84,096	1918	231,605	1,812,601
			1919	162,000	.....

[1] Prior to December, 1916, California was the only producing State.

DOMESTIC RESOURCES AND LOCALITIES OF PRODUCTION.

Magnesite occurs in commercial quantities in California, Nevada, and Washington. Reports of workable deposits in other States have not been verified.

Domestic production by States—magnesite, crude.

[From Mineral Resources, U. S. Geological Survey.]

State.	1916		1917		1918	
	Quantity (short tons).	Value.	Quantity (short tons).	Value.	Quantity (short tons).	Value.
California [a]	154,259	$1,388,331	211,663	$2,116,630	84,077	$761,811
Washington [b]	715	5,362	105,175	783,188	147,528	1,050,790
Total	154,974	1,393,693	316,838	2,899,818	231,605	1,812,601

[a] California 1919 production is estimated by F. McN. Hamilton, State mineralogist, as 42,000 short tons.
[b] Washington 1919 production is estimated by U. S. Geological Survey as 120,000 short tons.
[4] Testimony of Hon. James F. Burke, Hearing on Magnesite, July 16 and 17, 1919, p. 193.
[5] U. S. Geological Survey.

quartzite, into which basic igneous rocks have been intruded. Regular quarrying methods are employed in getting out the ore. Tunnels are run into the hill at convenient points and raises are put up to the quarry floor. The ore drops through such raises into small cars, which are trammed by hand to the surface.[9]

In eastern Canada, Quebec possesses the only known workable deposits of magnesite. Quarrying is carried out by open cast methods, the rock being broken down by blasting and sledging to "one-man size." The quarried material is cobbed to separate it from excessive amounts of serpentine and highly dolomitic rock.

In Austria the deposit at Veitsch has one of the largest quarries, and is representative of the methods of mining and preparing magnesite in Austria and in Hungary. At Veitsch the magnesite, which occurs in the form of a lens, is quarried on the slope of a hill in a series of terraces about 50 feet apart. The entire work extends through a vertical distance of 500 feet. The huge magnesite lens is nearly three-quarters of a mile long and over 1,000 feet in width and extends to a considerable depth. The material is blasted out of the solid by the ordinary methods of rock quarrying. It is next broken in pieces which can be handled readily by one man and the dolomite and quartz picked out. Even in the best sections of the deposits there is a large quantity of gangue material, and estimates of the waste rock vary from one-half to two-thirds of all the material quarried. The coarse material is cobbed to free it as far as possible from impurities like schist, dolomite, and quartz, and the lumps are sorted. The cleaner portions of the magnesite are reduced to pieces about the size of a man's head. Less pure portions have to be broken into pieces about fist size. These dressing operations involve a considerable loss of magnesite in the form of small fragments too small to be burned in shaft kilns. The raw material thus obtained in the quarries at Veitsch is transported by gravity planes to the sintering kilns at the foot of the hill.[10]

CALCINING METHODS.

In the United States calcination is effected in different types of kilns: (1) Bottle-shaped kilns; (2) vertical kilns resembling limekilns; and (3) rotary kilns, like those used in the manufacture of cement. Distillate or crude oil is the chief fuel in use in California, but coke is employed at one plant. The distillate is sprayed with air or steam into the four different compartments of the bottle-shaped kilns and the waste gases serve to heat the crude ore as it descends from the intake to the reverberatory chambers, where actual calcination takes place. Coke, where used, is mixed directly with the crude magnesite,

[9] Min. and Sci. Press, Aug. 30, 1919.
[10] Phalen, W. C.: Mineral Investigations of Bureau of Mines.

and its content of ash, therefore, has to be as low as possible. At most plants there is good economy of waste heat and action is practically continuous in all the different types of kilns.

In general, it may be said that American practice is comparable with foreign practice so far as rotary kilns are concerned. The sintering temperatures required for the production of dead burned magnesite are practically the same—approximately 2,800° F.—in Austria, Canada, and the United States.

Capacity of kilns varies according to the different types. The usual practice in the bottle-shaped kilns gives 15 to 20 tons of calcine per 24 hours; in 125-foot rotary kilns, 60 to 75 tons per 24 hours; and in the vertical kilns, 7 tons per 24 hours. In the bottle-shaped kilns only coarse lump magnesite can be calcined; the fine can not be used for the reason that it obstructs the draft. In rotary kilns all sizes may be calcined, fine as well as lump.[11]

At the plant at the Hemet magnesite mine, Riverside County, Calif., a typical property, hand sorting is done on a 30-inch by 50-foot belt conveyor. The rejections from the sorting belt are run directly to the waste conveyor, which carries the material to the waste dump. The 12-inch conveyor takes the magnesite from the sorting plant to a Gilbert washing screen, where it is washed before going to the ore bin. The water after screening the magnesite is run to a Dorr thickener, where the solids are settled out. The clear water is again used. From the ore bin at the washer the magnesite is carried to the mill by a gravity surface tram.

From the 300-ton ore bin the ore is fed to a Wheeling crusher, set at 1 inch. The material after passing the crusher is elevated to the feeder supplying the kiln, which is of the rotary type, 6 by 60 feet, making one revolution per minute. It takes the material about 45 minutes to pass through the kiln, and at the end of the calcination the magnesite is discharged on a steel conveyor which distributes it on the cooling floor.

From the cooling floor the material is passed over a magnetic separator to take out any iron before going to the grinders. The grinding is done in two stages. The coarse grinder is a steel plate mill which takes the 1-inch material and crushes it to about eight mesh. The fine crushers used are Sturtevant emery mills, which take the material at 8 mesh and make 98 per cent pass 100 mesh in one operation. From the grinders the material is elevated to the bin which supplies the packing department, where the material is all packed in barrels for shipment. The entire plant is operated by electric power.[12]

Calcination yields two products. If the burning is carried to the point where 3 to 4 per cent of carbon dioxide is left, the product is

[11] Min. and Sci. Press, Aug. 30, 1919.

[12] Eng. and Min. Jour., June 28, 1919.

referred to as "caustic" and is consumed principally in the flooring trade. Magnesia in this form is useless as a refractory material, because it absorbs moisture and CO_2 gas from the atmosphere and shrinks in volume when exposed to furnace temperatures. If burned to the point where it contains about one-half of 1 per cent of carbon dioxide by weight, it is referred to as dead-burned. Approximately 90 per cent of the total consumption of the United States is of the latter product.

In Canada and Washington a dead-burned or "ferromagnesite" is being produced at about 2,800° F., which has much the same refractory qualities as the Austrian iron-bearing magnesite. The ore is reduced to 10-mesh size by roll crushing, some 20 per cent passing through 100 mesh. Mixed with 2 to 5 per cent of its weight of pulverized magnetic iron ore, it is calcined in rotary kilns, at a temperature sufficient to convert all oxide of magnesium present from the amorphous form to the crystalline, the latter being the stable and unchanging form of the oxide.

If the magnesia has practically no other oxides associated with it, the heat of the electric furnace (above 2,900° F.) must be used to accomplish the conversion. In the presence of other oxides the transformation takes place at temperatures which are practical in brick kilns and shaft furnaces (about 2,600° to 2,700° F.). The resulting material—"ferromagnesite"—is the refractory magnesia of commerce, and consists, mineralogically, of ferrite of magnesia (MgO, Fe_2O_3), cemented and bound by the silicate of magnesia ($2MgO$, SiO_2). In this manner American magnesite of low iron oxide content is brought into the same final form as the Austrian dead-burned magnesia, in which the other oxides occur naturally. The average analysis of the dead-burned magnesite produced by one of the large American companies during part of 1918 and 1919 is reported to compare with a composite analysis of 21 samples of Austrian dead-burned material as follows:

	Dead-burned magnesite.	
	American.	Austrian.
	Per cent.	*Per cent.*
MgO	86.04	84.97
CaO	3.11	3.10
Mn_2O_3	.....	.68
Fe_2O_3	7.02	7.96
Al_2O_3		
SiO_2	6.78	2.91
Ig. loss	.....	.32

A similar comparison of American and Austrian dead-burned magnesite appears in the testimony of the Harbison-Walker Refractories

Co. in tariff hearings before the Committee on Ways and Means, July 17, 1919:

	Dead-burned magnesite.	
	American.	Austrian.
	Per cent.	*Per cent.*
MgO	84.00	86.50
CaO	2.30	2.75
Mn_2O_3	.....	.....
Fe_2O_3	7.38	7.50
Al_2O_3		
SiO_2	6.40	2.50
Ig. loss	.50	.50

The average analysis of the crude mineral found in Austria-Hungary (reported in Chem. and Met. Engineering of Dec. 3, 1919) and of 24 samples of California and Washington magnesite, collected by the United States Geological Survey in 1917, is as follows:

	American.	Austrian.
	Per cent.	*Per cent.*
MgO	38.4–46.0	33–44
CaO	.3– 7.4	1– 3
FeO	.2– 2.8	.....
FeO and Al_2O_3	.....	2– 7
SiO_2	.5–14.7	1– 5
CO_2	43.7–51.7	50

In Austria, at the Veitsch sintering plant, continuous kilns of the bottle variety are used and producer gas is employed as fuel. Within the last few years a few plants have installed rotary kilns of the cement type, powdered coal being used as fuel.

The sintering temperature varies from 1,500° C. (2,732° F.) for bruenerite (Austrian magnesite) containing considerable iron oxide, to 1,700° C. (3,092° F.) for material poor in oxide. However easily the material sinters, it appears desirable to carry the temperature up to at least 1,500° C., but this temperature seems to be exceeded, as a rule, in the shaft kilns in Styria.

The magnesite, after being drawn from the kilns is quenched with water and crushed to walnut size or less. It is then classified mechanically by screening or sizing into three different sizes. Much of the caustic lime or calcined dolomite is removed in the first screening owing to its finely divided condition. From the screens it goes to the picking tables where the unburned magnesite, together with the dolomite and quartz, present in particles too small to have been removed at the quarries, are picked out. The magnesite in the larger sizes is again crushed and the smaller pieces repicked. The magnesite is finally crushed to the size of kernels of corn, picked over again, and sacked for the trade in packages of 150 to 200 pounds each.

In recent years, magnetic separators have been introduced which have resulted in an economy in the picking or sorting operation. If not magnetically treated, the finely divided material would necessarily contain particles of chist, quartz or other nonmagnetic minerals. It must be said, however, that the magnetic treatment involves some waste, since only magnesite containing iron is removable by this treatment. It adds to the expense and is presumably employed only when it is necessary to obtain a concentrated, uniform, and specially graded product.

INDUSTRIAL DEVELOPMENT.

At the outbreak of the war the California industry was established quite firmly on the basis of medium-scale production and simple marketing systems, largely contractual. Since the freight rate on calcined magnesite is the same as that on crude and the product weighs only about one-half as much, practically all the ore was calcined at the mine. Various types of kilns were in operation. Most of them were of the vertical type similar to those used for making quicklime—inexpensive to build, but rather wasteful of fuel. Crude oil was used at many plants, but in the more isolated sections wood was cheaper. The character of the California deposits was such that extensive installation of equipment was not warranted. Single mines rarely remained in steady operation for any great length of time and no very large reserves were proved in advance of mining. At the end of 1913 there was only one producing company; in the whole year only three companies had operated. Early in 1914, however, several old mines were reopened and a few new producers came in. The only large producer at any time before the war was the Tulare Mining Co., and almost its entire product was contracted for by the Crown Willamette Paper Co. Only a few hundred tons surplus came on the open market. This was sold to grinders in San Francisco, who retailed it to consumers. The more or less sporadic output of the smaller organizations—none of whom could have guaranteed an output of 500 tons a month—came on the market almost wholly in granular form ("caustic") and in bulk.

War stimulation of the industry came in the latter part of 1914. It affected the larger properties first, but there was soon a rapid development of new producers. Mines 20 miles from the railroad, that had never been commercially considered, were opened up and contributed to the output. One producer installed a large rotary kiln and later another similar to those employed for cement burning, and improved its equipment generally. Broadly speaking, however, the California industry responded to the increased demand for its product by multiplying the number of producers—16 of whom reported production in 1915, 65 in 1917—rather than by greatly expanding individual operations. In 1918, however, the demand for

the mineral suddenly ceased; many mines closed indefinitely and others felt compelled to reduce their output from one-third to one-half. Late in 1919, but seven California plants were in operation.[13]

In Washington the somewhat greater inaccessibility of the deposits and their much greater indicated extent offered more attractions to large capital than to individual operations. The largest producer in the field is the Northwest Magnesite Co., which is said to have expended about three-quarters of a million dollars on equipment and development work.

Four companies took part in the development of the Washington industry. A large part of the work done by these companies was purely development. The deposits are several miles from a railroad and the early operations involved hauling by wagon and motor truck. A year after opening its major deposits the largest producer completed a 5-mile aerial tram from the quarry to its new calcining plant, where three rotary cement kilns, 125 feet long by 7½ feet diameter, are installed. Both quarrying and calcining plants are fully equipped with modern machinery and labor-saving devices. Iron ore, in correct proportions, is added at the calcining plant for the production of "ferromagnesite," of similar composition to the Austrian material. This is said to be quite as satisfactory as the Austrian product for refractory purposes.

DOMESTIC CONSUMPTION.

The consumption of magnesite shows a marked increase, and there is promise of a still further development in the next few years as the utility of the caustic product becomes more widely established. In 1917 the apparent consumption, expressed as crude, was over 355,000 short tons, or about 25 per cent more than the consumption just before the war. The United States is the largest consumer of magnesite, and in 1913 its requirements amounted to over 65 per cent of the total world consumption, if 500,000 tons is considered as the world output for 1913. This quantity includes only exports from Austria-Hungary, and it is presumed that Germany, the second largest steel producer, must have used 150,000 to 200,000 tons of magnesite, and that the world's output was nearer 700,000 tons. If this is true, the United States used about 50 per cent of the world's production of magnesite.[14]

A recent estimate of the character of the consumption is that 82 per cent is used as refractory, 15 per cent in the plastic trade, and 3 per cent for chemical and medicinal purposes. The open hearth steel industry is the most important factor in the magnesite situation. While this industry is not wholly dependent on magnesite supplies, it is largely so. The partial substitution of dolomite, however, has

[13] U. S. Geological Survey.

[14] Bureau of Mines.

come to stay, and the amount of magnesite consumed per ton of basic open-hearth steel, which formerly was 6 to 14 pounds (dead burned), has lately been cut almost in half. The total amount used by the steel industry has not decreased on account of the much greater output of basic open-hearth steel. The use of magnesite in building trades has also increased to a marked extent, and will almost assuredly expand further.

SOURCES OF DOMESTIC SUPPLY.

Before the war over 90 per cent of the domestic supply of magnesite was imported. The preponderant supply—and practically all that was used in steel manufacture—was derived from Austria-Hungary. No other foreign sources of large supply of a satisfactory quality of material existed. The Grecian deposits furnished only "caustic" for use in plastic trades and in the manufacture of chemicals and heat-insulating material.

In 1917, however, the proportions were reversed and over 90 per cent of the domestic supply came from American deposits. The tendency in 1918, however, was toward largely increased importations of Canadian material. If there had been no restrictions on ocean shipments of this material (in the interest of ship saving), there would also have been large importations from Venezuela.

COSTS OF PRODUCTION.

In former years the bulk of shipments from California has been crude, but there are now a number of up-to-date calcining plants in California that are sending finished product to the eastern market. The Tariff Commission has made no independent investigation of production costs in the magnesite industry. Sworn statements of five of the largest companies operating in 1919 have been filed with the Commission indicating an average cost of production of $25.37 per ton (calcined magnesite) at shipping point. In three of these reports the direct labor cost is indicated, averaging 50 per cent of the total. The Department of Commerce, in a cablegram from the American consul general at Vienna, has received post-war figures on Austrian costs of producing magnesite, indicating that of a total cost f. o. b. Trieste of $12.30, $2.89 (or 23 per cent) is cost of labor. The Tariff Commission has had no opportunity to verify these figures and does not know from what source or with what accuracy the cost data have been assembled. It was contended in recent tariff hearings that $12.30 does not include all the costs; that in addition to $12.30 should be added $2.18 for general expenses, including interest, etc.; $3.21 for depreciation and depletion; and $4.25 freight and handling (Radenthein-Trieste), making a total cost f. o. b. Trieste of $21.94.[15]

The present transcontinental freight rate in the United States is the same for crude as for calcined material. Rates, June 25, 1918,

[15] Hearings before the Committee on Finance, U. S. Senate, Jan. 13, 1920, pt. 2, p. 87.

were $15.60+47 cents per short ton, Spokane to Atlantic points; $13.80+41 cents to Pittsburgh. Some decrease in transportation expense may eventually result from Panama Canal service, but the haul from mines to Pacific ports, handling at docks, and freight from Atlantic seaboard to consuming center (Pittsburgh) will reduce the freight differential via canal. A Panama rate of $7 per ton from Pacific to Atlantic ports was quoted at one time.

FOREIGN PRODUCTION.

Developed magnesite deposits outside of the United States that have been productive are located in Quebec and British Columbia (Canada); Santa Margarita Island, Lower California; Venezuela; Austria-Hungary; Greece; Norway; Spain; Germany; Russia; Macedonia; Transvaal; and India. Deposits, some of which have produced small amounts, are located in Ontario and New Brunswick, Canada; Cedros Island, Lower California; Asia Minor; Sweden; Rhodesia; Portuguese West Africa; Australia; China; Japan; Tasmania; and New Caledonia. The largest foreign producer has been Austria-Hungary, with Greece second. The production of other countries was of minor importance until the war resulted in cutting off the Austrian supplies from all but the Central Powers. The cutting off of these supplies caused stimulation chiefly in the North American output. There is little reason to expect that there will be any marked shift in the important sources of supply, although the relative importance of the major producers may undergo considerable readjustment.

Magnesite reserves of the world.

[Communication from Mineral Resources Division, U. S. Geological Survey.

	Short tons.
Austria-Hungary	120,000,000
Greece	5,500,000
Washington	7,000,000
California	750,000
Venezuela (Margarita Island)[16]	3,200,000

The indicated reserves of the two American producing States are included for comparison. The reserves in other countries have not been measured and no even approximately accurate estimate can be made as to the total resources of the world.

FOREIGN RESOURCES AND COUNTRIES OF LARGEST PRODUCTION.

The foreign countries that enter into the American magnesite situation are Canada, Austria-Hungary, Greece, Mexico, and Venezuela. Small exports have been made from countries other than those named, notably Norway (via Scotland), but they are not of sufficient importance to warrant discussion with reference to the United States.

[16] Caracristi, Chas. F. Z.: Eng. and Min. Jour., 107 (1919), p. 131.

Estimated world production.

[From Mineral Resources of the United States, Geological Survey, 1918.]

	1913	1917
	Short tons.	*Short tons.*
Australia	243	9,[illegible]
Austria-Hungary[1]	440,920	.....
Canada[2]	515	5[illegible]
Greece	106,482	1[illegible]
India	17,637	19,445
Italy	661	.....
Spain	902	1,[illegible]
Transvaal	661	850
Turkey	8,818	.....
United States	9,634	31[illegible]
Mexico, Norway, Russia	5,512	5,211
Total	592,075	57[illegible]

[1] Exports.
[2] Shipments. From Mineral Production of Canada, Canada Department of Mines.

Austria-Hungary.—The magnesite deposits of Austria-Hungary follow a belt that extends in a northeast line across the two countries. The workable deposits are in the form of lenses. Only 10 or 12 of these lenses are of sufficient size to be worked, but several of these are large. The largest deposit in the group is near the town of Veitch. It has been worked longer than any of the others and a huge quarry is located there. The magnesite occurs in lenticular masses in a belt of carboniferous rocks consisting mainly of metamorphosed shales, sandstones, conglomerates, and limestone. It is grayish in color when fresh, and contains sufficient iron carbonate to blacken it when calcined. Another large deposit in Austria is at Radentheim on the north side of the Millstatter Alps, where the material is quarried by great cuts and lowered by gravity to rotary kilns. This deposit was owned by an American company and much of the output came to United States ports. Both grain magnesite and magnesite brick were produced near the mine. Another American company operated in Austria-Hungary before the war, but both properties were taken over by the Government and operated, at least for a time, by Russian prisoners. Two of the larger local companies sold all their export product through a German firm.

Because of the huge size of the Austrian and Hungarian deposits and their comparative accessibility and the low wages the product can be marketed cheaper than any other known supplies. Even the best deposits in these countries contain a large quantity of dolomite and quartz gangue that must be sorted out by hand. But the extraordinary opportunity for cheap mining and the ease with which it may be calcined to a dead-burned state give these deposits a remarkable advantage over those of any other part of the world.

Considerable American capital, the amount of which is given as over $2,000,000, is invested by the American Refractories Co., Pittsburgh, Pa., in the Austrian magnesite industry; that company

having purchased the entire interest of the Austria-American Magnesite Co., of which it was formerly part owner.[17]

Greece.—Grecian magnesite is of the noncrystalline or amorphous type like that of California. The most important deposits are those of the island of Euboea, where they are found close to the seashore. Cheap water transportation to all the principal consuming markets is available under normal conditions. The largest veins are 50 feet or more wide and several hundred feet long, although veins of this size are not common. They are mined by open cuts and a very pure product is obtained by cobbing.

In 1914 the production was mainly in the hands of three companies, and practically all the product is distributed through one of them—a British company. Less than 2 per cent of the ore is dead-burned on the island and only about one-third of it is calcined before shipment. Before the war much of the crude material was shipped to northern Germany or Holland, where it was calcined and, in part, ground and packed for reexport as prepared "caustic" for making Sorel cement. Magnesite from Greece and California are practically identical, but previous to 1915 the California material could not compete with the Grecian ore, much of which came in as ballast because of high transcontinental freight.

Canada.[18]—The only important magnesite-producing district in Canada is Grenville, Quebec. Many other occurrences are reported. There are deposits of considerable extent in various parts of British Columbia which, on account of the cost of transportation, are not workable at the present time.

The magnesite in the Quebec deposits is mixed with dolomite and serpentine, and the product invariably is high in lime. However, they have an advantage over the American deposits on account of their location close to centers of consumption, and increasing amounts are imported into the United States at lake ports and along the St. Lawrence. The Quebec quarry deposits are also cheaper to mine than those of California. The Canadian geological survey reported in March, 1917, that the cost of Grenville magnesite laid down in the principal markets was from one-half to two-thirds that of the California product (presumably referring to crude). This advantage was expected to be further improved by construction of tramways from the deposits to the railroad. Canadian material can not be used for the manufacture of the best magnesite brick. Material for brickmaking must be rigidly limited as to lime content (6 per cent) and silicon (7 per cent). The Canadian material is suitable, in the main, only for grain manufacture (furnace bottoms).

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[17] Hearings before the Committee on Finance, United States Senate, Jan. 13, 1920, pt. 2, p. 64.

[18] Canadian deposits are fully described by Wilson: Magnesite Deposits of the Grenville District. Canadian Department of Mines, Memoir 98.

Mexico.—On the island of Santa Margarita, in Magdalena Bay, there are extensive deposits from which exports have been made to the United States. It is a mountainous island cut up by canyons in which massive magnesite several feet thick is exposed. Bowlders of the material strew the stream beds. Hundreds of thousands of tons are said to be in sight, and large quantities, requiring only to be broken up for shipment, can be obtained with no expense for mining. Some of this material was being calcined in California in 1917. The material is exceptionally pure, and the operations were conducted by Americans.

Venezuela.—Large deposits of the massive or California type are found on Margarita Island, off the coast of Venezuela. In 1915 500 tons were exported to the United States. Mines are developed sufficiently to produce 2,000 tons monthly of very high-grade material. During 1917 the output was about 10 tons a day and brought an average of $25 a ton, of which $19.50 was paid for freight. The properties are operated by residents of California.

COMPETITIVE CONDITIONS.

Dependence on transportation.—The important feature of the magnesite industry is its dependence on cheap transportation for the successful exploitation of its product. In California carbonic-acid gas bottlers were forced to resort to limestone in place of magnesite, largely because freight from mine to quarry to manufacturing plant more than offset the advantages of the material richer in gas. For this reason shipments of crude are restricted to very short hauls. Crude has, in fact, almost wholly disappeared from the city markets. The sudden increase in production in 1915 resulted in some resumption of shipments of crude magnesite from the mines, but these ceased as soon as kilns could be constructed at the new mines.

The freight rates by rail from San Francisco to Chicago just before the war were $10 a ton; to Illinois and Ohio points, $11; and to Pittsburgh and beyond, $12. The average price of domestic crude in the San Francisco market was about $8 a ton. The average import valuation of Grecian magnesite (which was more strictly competitive with the California product than the Austrian) was $7 to $8 per ton on board steamer in New York. Under free competition the definite line of equal price was invariably west of the Mississippi River. Since the largest markets are in the Eastern States the domestic output was restricted on a purely cost basis to the rather limited local market in California. Calcined (not ground) Euboean (Grecian) magnesite was usually sold in New York cheaper than was similar material at the mines in California. The competitive status of Austrian supplies was also dependent on the freight, since the dead-burned product in New York was even cheaper than Grecian "caustic."

A freight rate of $4 a ton from San Francisco to points on the Atantic seaboard through the Panama Canal was quoted when the canal vas first opened, but was later increased to $7 as the scarcity of ottoms became apparent. Eastbound magnesite, however, was ever sought by carriers.

When the supplies of Austrian magnesite were finally cut off the California producers became a factor in the eastern market, and for a time were practically free from outside competition. Later, however, Canadian deposits were developed, and, although the material contained much more lime than the domestic product and was consequently less desirable for open-hearth steel production, it was so much cheaper because of the relatively short haul that it became an important rival of the Pacific coast product. Washington deposits were discovered and opened up in 1916, and largely supplied the market for refractory material in 1917 and 1918.

Quality of product.—While the chief handicap to the domestic producers is their distance from the points of consumption, the extreme purity of the domestic product also had an important bearing on the situation. It is commonly assumed that the most refractory magnesite is the dead-burned calcined form (either as brick or in grains) containing little or no lime, silica, iron oxide, or alumina. Lime has a tendency to cause disintegration and also in steelwork may "become rotten," because of the absorption of phosphorus that should have gone only into the slag. All the other impurities have a tendency to lower the melting point. On the other hand, there is a preference among refractory users for the magnesites that carry a certain percentage of iron as do the Austrian and Hungarian products. While the small amount of iron present does lower the melting point slightly, brick and other calcined products made from it are more satisfactorily burned and hold their shape better when exposed to high temperature. The shrinkage is less, and less heat is required for satisfactory calcination than is the case with the purer American material. In order to meet this condition, one of the American producers has installed mixing devices for adding iron to its product prior to calcination.[19]

Another feature that may be mentioned under this head is the preparation of the material. Even before the war, Grecian magnesite was sold in California in competition with the domestic product for the plastic trade and at a higher price. Discounting the prejudice or established custom of calling for "Grecian" magnesite in specifications, the greater diversity of forms and packages in which the imported product was available and the fact that it could be bought

[19] Two California deposits contain enough iron so that magnesite brick are made without the addition of that material.

in small lots was a strong factor in its continued sale. The domestic producers invariably sold only in carload lots. Very little of their product was marketed in the ground condition ready for use. On the other hand, the imported material was ground, of more uniform grade, and packed in paper-lined barrels.

Foreign exchange.—Another influence probably affecting the relative competitive positions of American and foreign producers is the present low rate of foreign exchange. Comparatively one-sided trade relations have existed during the last five years between the United States and foreign countries, and the virtual abandonment of the gold standard in various European countries has resulted in the depreciation of their currencies. The competitive strength of Austrian magnesite is subject to whatever uncertainties attend the present exchange rates on the Austrian krone. The Tariff Commission is endeavoring to ascertain both the effects of any divergencies between foreign and domestic depreciations of currency and the effects of exchange rates due to the balance of trade on the competitive position of the foreign commodity in the American market.

IMPORTS.

Countries of origin.—The Department of Commerce publishes the countries of origin for importations of calcined but not of crude magnesite. In general, it may be said that Greece furnished a larger proportion of raw magnesite before the war than did Austria-Hungary. Raw magnesite has also been imported quite steadily from Canada in late years. The irregular imports from Mexico and Venezuela have been mentioned above, as has also the character of the importations from the various countries.

Most of the prewar importation of calcined magnesite from Netherlands, Belgium, Germany, and even the United Kingdom consisted of reexported Grecian "caustic," generally after calcining and repacking in those countries. Part of the imports from Great Britain (Scotland) was of Norwegian origin.

Imports of magnesite, calcined, not purified, by countries.

[Fiscal years.]

Imported from—	1911		1912		1913	
	Pounds.	Value.	Pounds.	Value.	Pounds.	Value.
Austria-Hungary	286,784,390	$1,282,298	198,208,783	$916,550	327,130,519	$1,564.2[illegible]
Germany	2,851,020	18,474	1,378,678	16,000	4,823,513	40.[illegible]
Netherlands	5,948,054	59,608	4,819,284	52,806	9,015,619	100.1[illegible]
Belgium	65,230	667	51,211	530	.....	.....
Greece	.....	.....	227,276	1,173	3,208,176	17,4[illegible]
Norway	242,716	1,648	325,760	1,893	.....	.....
United Kingdom	5,560	36	123,192	1,062	2,789	[illegible]
Canada	591,940	1,726	467,920	2,863	700,630	5.0[illegible]
All other	55,777	533	276,880	986	.....	.....
Total	296,544,687	1,364,990	205,878,984	994,463	345,181,246	1,72[illegible]

Imports of magnesite, calcined, not purified, by countries—Continued.

Imported from—	1914		1915		1916	
	Pounds.	Value.	Pounds.	Value.	Pounds.	Value.
ustria-Hungary	268,520,275	$1,298,136	104,171,512	$523,905	.....	.....
ermany	5,156,102	42,146	1,444,691	16,417	24,802	$365
etherlands	8,380,349	107,261	7,108,042	101,513	3,899,359	59,155
elgium	22,310	289	.....	.....	.....	.....
reece	6,464,400	20,070	8,873,777	47,511	22,825,795	136,701
orway	.....	.....	.....	.....	44,840	611
nited Kingdom	26,508	654	560,563	16,381	698,100	31,553
anada	808,650	3,300	1,895,424	14,065	4,879,714	54,383
ll other	115,722	1,351	2,641,421	25,590	.....	.....
Total	289,494,316	1,473,207	126,695,430	745,382	32,372,610	282,768

Imported from—	1917		1918		1919	
	Pounds.	Value.	Pounds.	Value.	Pounds.	Value.
ustria-Hungary	.....	.....	.....	.....	107,520	$664
reece	3,584,000	$28,032	.....	.....	.....	.....
orway	.....	.....	22,046	$482	.....	.....
nited Kingdom	1,568,424	86,224	1,864,794	105,507	925,120	53,480
anada	4,296,393	67,781	21,608,707	443,538	39,401,280	535,310
ll other	.....	.....	4,242	200	.....	.....
Total	9,448,817	182,037	23,499,789	549,727	31,433,920	589,454

The proportion of magnesite imported raw showed a gradual falling ff—from more than one-half the weight of the magnesite imported s calcined in 1902 (the first year for which separate statistics are ublished) to about one-twelfth the weight of calcines imported in he years immediately preceding the war—a natural result of estab-shed routes and the tendency to ship in the lightest possible form. 'he amount of calcined magnesite imported in 1914 was nearly 50,000 tons, valued at $1,500,000, or more than five times the uantity imported in 1904. On the other hand, the 11,000 tons of aw magnesite imported in that year was an actual reduction from ne annual importation a decade before.

When the war first cut off the importation of Austrian calcines, much larger proportion of raw material was imported, since no ther country had sufficient calcining facilities immediately to take are of the sudden demand. Even some of the Grecian magnesite hat ordinarily would have been calcined in Europe en route was hipped direct and the imports of raw magnesite from that country reatly increased as also did those from Canada later. In 1917 the nportation of crude magnesite was the largest on record, both as egards quantity and value, amounting to nearly 90,000 tons, valued t $750,000, or nearly 9 times the amount and 16 times the value of he 1914 imports. In that fiscal year the imports of calcine reached heir minimum—less than 5,000 tons,valued at only $182,000, or ess than one-thirtieth of the amount and about one-eighth the value f the 1914 imports. In 1918 the import restrictions of the United

States Shipping Board cut down the amount of crude magnesite imported to one-tenth that imported in the previous year. Increased rail and lake boat shipments from Canada which had meanwhile increased its calcining capacity to keep up with the sudden increase in its mine output resulted in more than doubling the importation of calcined material.

IMPORTS FOR CONSUMPTION.

The imports for consumption since 1907 are as follows:

Imports of magnesite for consumption.

Fiscal year.	Crude			Calcined, not purified.		
	Pounds.	Value.	Value per unit of quantity.	Pounds.	Value.	Value per unit of quantity
1907	4,857	$156,722.00	$0.004	143,891,572	$696,715.45	$0.005
1908	4,665	141,992.00	.003	146,860,775	706,088.00	.005
1909	2,655	80,558.00	.002	188,961,370	871,383.80	.005
1910	3,514	108,623.25	.003	225,895,904	1,026,962.00	.005
1911	3,990	127,344.00	.003	298,225,507	1,362,120.00	.005
1912	2,995	88,482.00	.003	204,997,478	990,241.00	.005
1913	3,980	111,276.00	.003	345,222,155	1,731,443.00	.005
1914	2,005	46,611.00	.002	298,939,577	1,495,272.00	.005
1915	3,009	80,625.00	.002	125,893,407	751,766.00	.006
1916	10,899	281,620.00	.003	32,372,610	282,788.00	.009
1917	17,338	748,951.00	.004	9,447,817	182,037.00	.019
1918	1,967	104,947.00	.008	22,764,029	535,202.00	.024
1919	660	26,072.00	.008	28,199,360	563,382.00	.020

PRICES.

The price statistics for magnesite are somewhat complicated because of the variety of grades and methods of packing. Except for Austrian dead-burned material, the different products have not been well standardized and statistics for successive years are not comparative. Magnesite "raw" and "calcined" are the only two classes quoted in trade journals with any degree of regularity. And these quotations are nominal and rarely reflect even major fluctuations.

Before the war the lowest prices for dead-burned Austrian magnesite were $15.72 f. o. b. docks at Philadelphia, $15.60 f. o. b. New York, and $15.20 f. o. b. New Orleans. These figures represent practically the minimum prices that had been reached in 15 years. In rough figures the average price of calcined magnesite along the Atlantic seaboard was $16.25 per net ton. Chicago prices in 1914 were $26 per short ton.

The minimum prewar price of raw magnesite was $8 per net ton on the Atlantic seaboard, and was usually quoted higher. Materia (Grecian) calcined for medicinal and other uses ranged from $2 to $25 per ton according to its purity and the care that had been exercised in sorting. Fine ground calcined brought up to $35 and $40. Little information can be gained by a study of the import valuations except that they bear out the fact that shipments from

Europe, except from the producing countries are of material especially ground and packed. Magnesite from the United Kingdom has the highest valuation ($49.40 per ton in 1914), while the Austrian material was valued at $9 to $10 and the Grecian imports were generally valued at slightly over $10.

The only quotations for the domestic product before the war were in California. In general they did not differ greatly from the quotations for imported magnesite in the East. In the early years of the war, San Francisco became the dominant market. Quotations rose from $22 to $25 per ton for crude calcines in sacks and $40 to $55 for the ground product in paper-lined barrels.

New York market quotations in June, 1919, for the domestic product were $30 to $35 per ton for crude and $50 to $60 per ton for calcined. There was no European magnesite on the market at that time.

Austrian calcined magnesite began arriving in this country during July, 1919, and in the 10 months (July, 1919, to April, 1920) Commerce and Navigation Reports show a total importation of 13,573 short tons, valued at $246,978—an average import valuation of $18.20. Ten thousand nine hundred and seventy-seven tons of this were shipped from Italian ports.

Prices of magnesite, 1913, per short ton.

New York market:	
Grecian, Euboean—	
Calcined, "caustic" fine ground (in paper-lined barrels)	$25.00–$35.00
Calcined "caustic," not ground (in sacks)	17.50– 20.00
Crude (bulk)	7.00– 8.00
Austrian, calcined, dead-burned, crushed, or fine ground (bulk)	16.15– 16.25
Pacific coast markets:	
Domestic, calcined—	
"Caustic," fine ground (in paper-lined barrels)	30.00– 35.00
Not ground, dead-burned (in sacks)	20.00– 25.00
Norwegian, calcined, dead-burned, crushed, or fine ground	22.50

RATES OF DUTY.

Magnesia.

Act of—	Paragraph.	Tariff classification or description.	Rates of duty, specific and ad valorem.
1883	60	Magnesia, medicinal, carbonate of	5 cents per pound.
1883	61	Magnesia, calcined	10 cents per pound.
1890	24	Magnesia, carbonate of, medicinal	4 cents per pound.
		Calcined	8 cents per pound.
1894	24	Magnesia, carbonate of, medicinal	3 cents per pound.
		Calcined	7 cents per pound.
1897	31	Magnesia, carbonate of, medicinal	3 cents per pound.
		Calcined, medicinal	7 cents per pound.
1909	31	Magnesia and carbonate of, medicinal	3 cents per pound.
		Calcined, medicinal	7 cents per pound.
1913	42	Magnesia; calcined	3½ cents per pound.
		Carbonate of, precipitated	1½ cents per pound.

Magnesite.

Act of—	Paragraph.	Tariff classification or description.	Rates of duty, specific and ad valorem.
1883	620	Magnesite, or native mineral carbonate of magnesia	Free.
1890	640	do	Do.
1894	543	do	Do.
1897	605	Magnesite, crude or calcined, not purified	Do.
1909	618	do	Do.
1913	539	do	Do.
1909	84	***Magnesite brick*** not glazed, enameled, painted, vitrified, ornamented, or decorated in any manner.	25 per cent ad valorem.
		If glazed, enameled, painted, vitrified, ornamented, or decorated in any manner.	35 per cent ad valorem.
1913	71	***Magnesite brick*** not glazed, enameled, painted, vitrified, ornamented, or decorated in any manner.	10 per cent ad valorem.
		If glazed, enameled, painted, vitrified, ornamented, or decorated in any manner.	15 per cent ad valorem.

COURT AND TREASURY DECISIONS.

In a decision in 1876, ground magnesite, or native carbonate of magnesia, composed of magnesia 47.6 and carbonic acid 52.4, was classified as carbonate of magnesia, although differing in some respects from the more common article known by that name. (Dept. Order, T. D. 2875.)

Calcined magnesite, declared to have all the characteristic properties of cement and to be used as a mortar in cementing magnesite bricks, was classified as cement under the act of 1883. (T. D. 9375.)

An importation described as calcined magnesite, or magnesite which has been reduced to pulverization by heat and then ground and chiefly used as a cement for lining furnaces, was held not within the provisions in the act of 1894 for "magnesite, or native mineral carbonate of magnesia," nor gypsum ground or calcined, but dutiable as cement other than Roman, Portland, or hydraulic. (G. A. 3370, T. D. 16851.)

A similar importation was classified as cement by the customs officers under the act of 1897, but the Board of General Appraisers held it exempt from duty as "magnesite, crude or calcined, not purified." (G. A. 5003, T. D. 23316.)

Magnesite brick was held dutiable under the act of 1897, paragraph 87, as "brick, other than fire-brick," the term "fire brick" being restricted to brick made from fire clay. (U. S. *v.* Hempstead, 153 Fed., 483; T. D. 28076.) An importation described as "magnesia brick" also was held dutiable as brick and not as fire brick under the act of 1894. (Fleming Cement & Brick Co. *v.* U. S., 124 Fed., 1014.)

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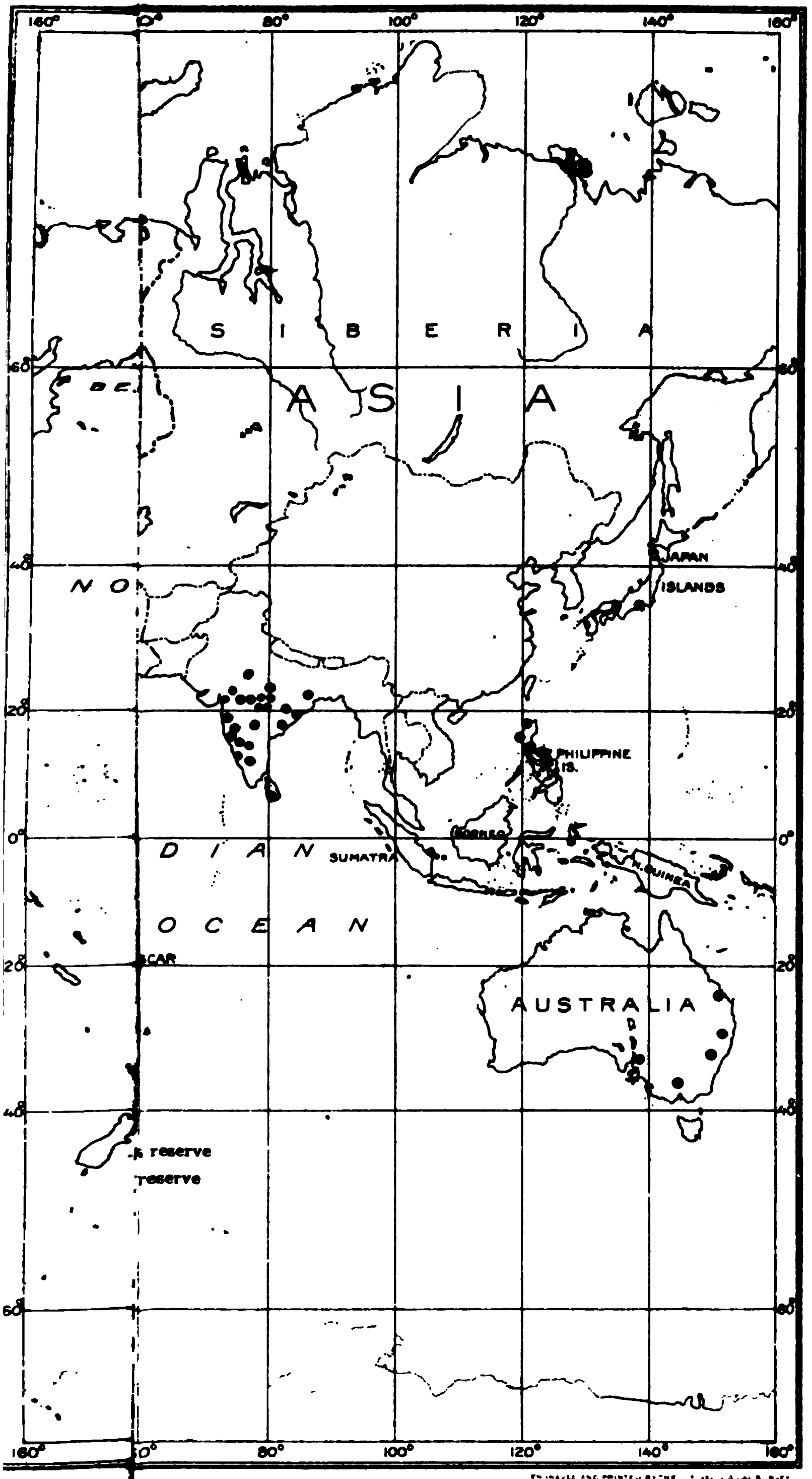
MANGANESE



SITS OF THE WORLD

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MANGANESE.

SUMMARY.

IMPORTANCE OF THE INDUSTRY.

Ninety-six per cent of all manganese consumed goes into steel manufacture. In the ordinary Bessemer and open-hearth practice of recent years from 10 to 17 pounds of manganese has been added as a deoxidizing agent to every ton of steel produced. The balance goes into the electric dry-battery, glass-making, chemical, and paint industries.

FOREIGN AND DOMESTIC NATURAL RESOURCES.

In comparison with the reserves of manganese ore in the operating districts of Russia, India, and Brazil, which amount to some 133,000,000 tons, the deposits of the United States are moderate. Estimates of the Geological Survey and Bureau of Mines justify the assumption that the minimum proved manganese resources of the United States are approximately 800,000 tons of high-grade ore with 1,130,000 tons of "additional" high-grade reserve in prospect. Certain Montana reserves are not included in these figures, and large additional reserves of low-grade material—running down to 25 per cent manganese content—are known to exist. These, with the known deposits of still lower manganese content—down to 5 per cent—make a total of over 17,000,000 tons of low-grade material in sight. There is a possibility that our domestic resources are greatly in excess of these indicated reserves; producers in the Butte district maintain that several million tons of high-grade ore are available in this section alone. Although great bodies of manganese ore are known to be in place in the Butte silver-zinc mines, no authenticated estimates of tonnage are available.

The foreign ores are of better average grade and more easily mined than the American deposits. Generally speaking, foreign ores average 45 to 55 per cent manganese content and domestic "high grade" 35 to 45 per cent. The present American sources, except a few in the South and the Montana districts, are remote from points of consumption and characterized by the costly operating conditions of pioneer mining work.

Manganese mining is not an industry characterized by heavy investments, although a few producers have recently installed extensive surface-mining equipment and concentrating machinery. For the most part operations are near the surface, deep manganese mining occurring only in a few instances. The American industry outside of the Butte, Mont., district, is mainly in the hands of small operators, many of them formerly miners of other metals.

The number of shippers of high-grade ore in 1918 was about 250, Montana leading in the United States as a high-grade producer, with 23 operators; California, 31 shippers; Nevada, 11; Arkansas, 10; Colorado, 11. The industry extends through Arizona, Alabama, Georgia, New Mexico, Oklahoma, the Carolinas, Tennessee, Utah, Wyoming, and Virginia.

DOMESTIC SUPPLIES.

For a decade before the European war the United States produced less than 1 per cent of its total manganese ore supplies. The cutting off of foreign sources forced an expansion of domestic production from about 3,000 tons in 1913–14 to over 300,000 in 1918 approximately 33⅓ per cent of war-time requirements. If all the prospects nearing the producing stage at the time of the armistice were to become actual shippers, domestic manganese could equal the prewar requirements of 350,000 tons.

A strong preference exists on the part of the main consuming interest, the United States Steel Corporation, for foreign manganese whenever imported ore is obtainable. The purity and high uniform grade of the foreign material are responsible for this, and the consumers have preferred getting 2,000 to 5,000 tons in a single shipload, handled in one sampling, assay, and settlement, to assembling a similar tonnage from a score or more of domestic shippers.

FUTURE COMPETITIVE CONDITIONS.

To make an accurate forecast of the after-war cost of production of manganese ore in the United States is difficult. Foreign mining costs, except in Cuba and Brazil, are available only for periods before the war. Although individual costs were frequently less, the estimated average cost of the 300,000 tons of domestic ores produced in 1918 was $16 per ton on railroad cars at the mine, or $26.80 per ton delivered at the principal consuming center, Pennsylvania. It is estimated by the Bureau of Mines that this total delivered cost may decrease to a figure slightly over $22 per ton, or 55.6 cents per unit of manganese, as against 40 cents per unit for the higher-grade ores imported from Cuba and Brazil. Present Russian and Indian costs are not known, but it is probable that the costs of Cuban and Brazilian ores will have to be reduced still further to compete with the output from these countries.

The higher grade and uniform character of the foreign ore give it decided preference from the consumer's standpoint. Even at the same price per unit, the higher grade ore invariably rules the market.

Although not impossible, it would be only under the strongest pressure that domestic producers could supply the full requirements of a normal United States demand for manganese. Deposits have not been brought into condition to deliver the present annual requirements, and even were facilities available, it is estimated by the Geological Survey and Bureau of Mines that under this production known reserves indicate the exhaustion of American resources in a comparatively few years.

THE MANGANESE INDUSTRY.

Act of 1913, tariff paragraphs:

Manganese, oxide and ore of (par. 540), free.

DESCRIPTION.

Manganese is not found in the metallic state in nature; it occurs only in combination with other elements, as oxide, carbonate, or silicate, the oxides being the most common.

Principal manganese minerals.

Mineral.	Composition.	Percentage manganese.
Polianite	MnO_2	63.2
Pyrolusite	$MnO_2.H_2O$	60–63
Psilomelane	$MnO_2(MnKBa)O.H_2O$	45–60
Wad, Bog manganse, etc	Impure mixture of hydrous oxides	5–50
Manganite	$Mn_2O_3.H_2O$	62.4
Braunite	$3Mn_2O_3.MnSiO_3$	69
Franklinite	$(FeZnMn)(FeMn)_2O_4$	10–19
Rhodocrosite	$MnCO_3$ (carbonate)	47.56
Rhodonite	$MnSiO_3$ (silicate)	41.9
Tephroite (manganese olivine)	Mn_2SiO_4 (silicate)	54.3
Spessartite (manganese garnet)	$3MnO.Al_2O_3.3SiO_2$	33.3

The domestic supply of manganese comes from four classes of materials: (1) Manganese ores, (2) manganiferous iron ores, (3) manganiferous silver ores, and (4) manganiferous zinc residuum.

The limiting percentage of manganese distinguishing a manganiferous iron ore from a manganese ore is not fixed but varies according to the use to which the ore is put. For steel manufacture manganese ore may contain 5 per cent of iron or even more and still be termed a manganese ore, but for chemical purposes the manganese ore should as a rule contain less than 1 per cent of iron.

Manganese ores are those which contain at least 35 per cent manganese and otherwise conform to the specifications of the trade in which they are used.

Manganiferous iron ores consist of mixtures of manganese and iron oxides and hydrous oxides which, though usually containing manganese in excess of 5 per cent, may contain as little as 1 per cent. The proportion of iron in such ores is highly variable but usually exceeds 40 per cent.

Manganiferous silver ores consist of mixtures of manganese and iron oxides and hydrous oxides, with small quantities of silver and

lead minerals. As a rule the iron content exceeds the manganese content, but locally the iron is altogether absent. These ores are more important as fluxes in lead and copper smelting than as sources of recoverable manganese.

Manganiferous zinc residuum is an artificial furnace product consisting of manganese and iron oxides in a matrix of slag. It is obtained from zinc volatilizing and oxidizing furnaces using New Jersey zinc ores. The residuum consists largely of iron and manganese oxides, the zinc having been removed by volatilization and collected as zinc oxide. The manganese content is 14 to 15 per cent.

USES.

The chief use of manganese ores is for making ferromanganese and spiegeleisen, alloys required in steel making. Fully 96 per cent of the manganese ore consumed in the United States goes into the manufacture of steel. Practically all steel contains manganese and of all the essential alloys ferromanganese is used in the largest quantity. Under present metallurgical methods it is impossible to produce open-hearth and Bessemer steel without adding on the average one-half of 1 per cent manganese, and special steels are made containing up to 10 or 12 per cent. Manganese alloys when added to steel serve as deoxidizers and recarburizers, and impart certain essential qualities—toughness and hardness.

Manganese is also a useful alloy in bronze. Its compounds, generally the oxide, are used in glass making and in electric dry batteries. It is employed in chemical works in the manufacture of chlorine and bromine; is used as a drier for varnishes, and as a coloring material in pottery and brick making, and for green and violet paints. The consumption of manganese ore for these purposes, however, is relatively small compared to its use in steel.

DOMESTIC PRODUCTION.

For over a decade previous to 1915 the domestic production of manganese ore rarely exceeded 4,000 tons annually. Upon the outbreak of hostilities in Europe (August, 1914), the need for manganese became increasingly evident, and as the demand for manganese alloy by steel manufacturers became more urgent prices of the ore rose rapidly. This condition resulted in strenuous efforts to increase production. In 1915 the production of ore, 35 per cent or over in manganese, increased to nearly 10,000 tons; in 1916, to 31,000 tons; in 1917, to 129,000 tons; and in 1918, to approximately 306,000 tons.

HISTORY.

Prior to 1870 the value of manganese ore in the iron industry was not generally recognized. The iron used was largely in the form of

ast and wrought iron, to which no manganese is added, or of cru-ible steel in which only a small quantity is required. The develop-ıent of the Bessemer and open-hearth processes of making steel bout this time created a demand for manganese alloys, and during ecent years it has been the ordinary practice to add from 10 to 17 ounds of manganese, in the form of ferromanganese or spiegeleisen, o every ton of steel produced by these processes.

For a decade before the European war (1914–1918) the United tates produced less than 1 per cent of its supply of manganese, the est being imported from British India, Russia, and Brazil in the orm of ore, and from England in the form of ferromanganese. The losing of the European supply and the partial closing of the British ndian supply, under war conditions, made it necessary to turn to Brazil for our foreign manganese. At the same time vigorous steps ere taken to develop domestic resources. American citizens were rged to embark on new mining ventures with the encouragement nd advice of the Government through the War Industries Board, hipping Board, Geological Survey, and Bureau of Mines.[1] The esponse measured in actual tonnage of manganese and other muni-ion minerals was remarkable, yearly production of manganese in-reasing almost a hundredfold. The tonnage of high-grade (35 per ent) ore increased from 4,000 tons in 1913 to 305,869 tons in 1918. ow-grade ores containing from 10 to 35 per cent manganese were sed to a larger extent for making spiegeleisen and for direct addition n the smelting of pig iron, without going through the form of ferro-lloy. The number of shippers of high-grade ore increased from 18 n 1914 to 247 in 1918.

Even before the passage of the war minerals bill (October, 1918) it as clear that the necessity for legislative stimulation of produc-ion for most of the munitions minerals had passed. Consumption ad not come up to the preliminary estimates prepared by the ifferent Government departments, and the supply from various ources, on the other hand, far exceeded the preliminary production stimates by prospective shippers to the Government in the early part f the year. The natural result of a combination of these factors—verestimate of consumption, change in rate of consumption, under-stimate of production, with imports continuing to enter the country n spite of embargo—was a serious congestion of stocks. At the begin-ing of 1919 consumers were stocked with considerably over a year's equirements in manganese.

As a result of the domestic developments in the manganese situa-ion the Government found it possible in 1917 and 1918 to restric-he importation of ore from Brazil and other foreign countries having long haul, for the sake of conserving shipping, while importations

[1] See war minerals relief act, Mar. 2, 1919.

from Cuba and Central America were encouraged. Imports of ferromanganese were also restricted early in 1918, but later in the year an exception was made and 12,000 tons were allowed to enter from England.[2]

CONCENTRATION PRACTICE.

The minerals associated with manganese are quartz and iron, principally limonite; barite is of rare occurrence although occasionally found. As the specific gravity of iron is similar to that of manganese it is practically impossible to effect a separation mechanically; consequently it is common practice to hand pick the ore coming from the finishing apparatus when a product low in iron is desired. As a rule, however, no attempt is made to separate the small amount of iron present in ores coming from the usual manganese deposit.

The usual specific gravity of quartz is ordinarily about 2.65, but quartz occurring in connection with manganese deposits, particularly the sands resulting from the decay of limestone and other formations, is often rough and porous and has a specific gravity of 1.8 to 2. The average specific gravity of manganese that must be treated is about twice that of quartz, the principal impurity that must be separated, and this difference is ample to insure clean separation.

The work of cleaning manganese ores as practiced in the various districts can hardly be considered standard except in general outline; that is, the use of grizzlies, log washers, screens, and picking belts, with a growing tendency toward the employment of jigs. Few American plants have a full installation of essential equipment, while a number are operating with the irreducible minimum of equipment, namely, a log washer and a screen, or simply hand jigs.

Existing practice in the treatment or cleaning of manganese ore varies from fair to very bad with a wide range between, but as a whole the practice is poor. Plants are modeled after others already operating, often on the assumption that because a plant is in operation it must be doing good work, which is frequently far from being true. However, the essential principles of a prevailing practice are likely to be sound and particularly adapted to the special conditions and needs of the district and are likely, therefore, to develop ultimate efficiency.[3]

LOCALITIES OF PRODUCTION.

Manganese ore deposits occur in many parts of the United States, but are most abundant in Montana, the Appalachian and Piedmont regions, in the southern Mississippi Valley, and on the Pacific coast. Small deposits occur in New England and in the Great Basin region.

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[2] Import restrictions effective during the war period are given below under "Imports."

[3] Crane, W. R.: U. S. Bureau of Mines.

Up to 1918 the principal producing districts had been the James River, Staunton River, and the Blue Ridge regions in Virginia, the Cave Springs and the Cartersville districts in Georgia, the Batesville district in Arkansas, and the Livermore-Tesla districts in California.

The greater use, small and rapidly decreasing stocks, advancing prices, and other conditions in the manganese situation brought about by the war led to intensive prospecting and abnormal production in 1918. During that year, 15 States that had no manganese mines in operation before the war produced over 250,000 tons of high-grade ore. Montana led in production, mining in 1918 over 60 per cent of the country's total. Other important producing States during 1918, following in order of quantity mined, were: California, Nevada, Arizona, and Virginia.

Manganiferous iron ores (5 to 35 per cent Mn), which prior to the war (1914) had been produced chiefly in Minnesota and Colorado, were in 1918 produced in 12 or more States, the principal ones being in order of quantity produced: Minnesota, Wisconsin, Colorado, Nevada, and New Mexico.

RELATION OF DOMESTIC PRODUCTION TO DOMESTIC CONSUMPTION.

The approximate available supply of manganese metal in the United States during the normal years (up to 1914) preceding the European war, may be taken as a fair indication of the domestic consumption. During the four years before the war, 1911–1914, inclusive, the amount consumed annually ranged from 176,000 long tons to 291,000 long tons of manganese, the average for the four-year period being 238,900 tons. During the same years the manganese contents of ores imported averaged 132,300 tons, and of speigeleisen and ferromanganese averaged 79,350 tons. The domestic production of manganese was small, between 24,000 and 34,000 tons annually, the average being 27,300 tons, or little more than 11 per cent of the consumption.

Under the influence of high prices and a keen demand, as a result of the greatly increased output of steel for the warring nations in Europe, domestic production of high-grade manganese ore began to increase rapidly, amounting in 1915 to 2.9 per cent of the total consumption of ore; to 5.2 per cent in 1916; to 17 per cent in 1917; and to 38.4 per cent in 1918. The imports of ferromanganese declined during this same period from 55,263 tons in 1915 to 26,906 tons in 1918.

Consumption of manganese (total metal) in the United States.[1]

Calendar year.	Domestic production.			Imports for consumption.			Exports.[4]	Consumption.	
	Ore.[2]	Zinc residuum.[2]	Total.	Ore.[3]	Spiegeleisen.[3]	Ferromanganese.[3]		Total.[5]	Proportion produced in United States.
	Long tons.[6]	*Long tons.*[6]	*Long tons.*[6]	*Long tons.*[6]	*Long tons.*[6]	*Long tons.*[6]	*Long tons.*[6]	*Long tons.*[6]	*Per cent*
1910	9,212	19,890	29,102	113,903	5,077	91,382	1	239,463	12.15
1911	8,561	15,848	24,409	83,110	4,194	64,210	5	175,918	13.87
1912	8,880	15,177	24,057	150,699	203	79,310	2	254,267	9.46
1913	12,022	14,825	26,847	162,201	15	102,456	174	291,345	9.21
1914	19,453	14,529	33,982	133,228	574	66,398	36	234,146	14.51
1915	40,276	23,101	63,377	150,766	40	44,210	1,174	257,219	24.64
1916	104,147	28,828	132,975	267,697	.....	72,742	499	472,915	28.12
1917	201,149	22,523	223,672	296,087	794	33,575	2,365	551,763	40.54
1918	313,211	21,285	334,496	230,844	394	21,525	2,939	584,270	57.25

[1] Given in equivalents of metallic manganese: exclusive of manganese in manganiferous iron ores containing 10 per cent manganese.
[2] Calculated from production figures in Mineral Resources, and Geological Survey records. Ore 35 per cent and over manganese, figured as 42.5 per cent; ore 10 to 35 per cent manganese, figured as 20 per cent; zinc residuum figured as 14.5 per cent.
[3] Calculated from Department of Commerce statistics: ore as 47 per cent manganese, spiegeleisen as 20 per cent manganese, and ferromanganese as 80 per cent manganese.
[4] Ore; includes a small amount of ferro exported in 1917; ore taken as 47 per cent and ferro as 80 per cent manganese.
[5] Production plus imports minus exports.
[6] Manganese content.

EXPORTS.

The United States is an importer and not an exporter of manganese ore. No domestic manganese is exported, and only insignificant quantities of the foreign ore imported are reexported; nearly all of these go to Canada. In 1918 small amounts of ferromanganese were exported to Canada, Italy, and Great Britain.

Manganese and manganiferous ores produced in the United States.[1]

Year.	35 per cent +.	10 to 35 per cent.	5 to 10 per cent.
	Gross tons.	*Gross tons.*	*Gross tons.*
1910	2,258	41,260	19,841
1911	2,457	37,584	6,453
1912	1,664	40,863	10,654
1913	4,048	51,512	7,891
1914	2,635	91,666	6,509
1915	9,613	180,953	14,782
1916	31,474	453,853	90,473
1917	129,405	730,759	[2] 330,512
1918	305,869	916,163	470,136
1919	60,270	217,080	388,132

[1] Mineral Resources and Geological Survey records. Figures represent ore marketed (or shipments).
[2] Includes 200,327 tons manganiferous iron ore from Wisconsin, containing approximately 5 per cent of manganese.

Production of manganese and manganiferous ores in United States by States.[1]

State.	1916			1917			1918			1919[1]		
	35 per cent +.	10 to 35 per cent.	5 to 10 per cent.	35 per cent +.	10 to 35 per cent.	5 to 10 per cent.	35 per cent +.	10 to 35 per cent.	5 to 10 per cent.	35 per cent.	10 to 35 per cent.	5 to 10 per cent.
	Gross tons.	*Gross tons.*	*Gross tons.*	*Gross tons.*	*Gross tons.*	*Gross tons.*	*Gross tons.*	*Gross tons.*	*Gross tons.*	*Gross tons.*	*Gross tons.*	*Gross tons.*
Alabama	(2)	.....	.....	264	.....	.....	709	443	.....	40	.....	.....
Arizona	3,060	7,392	.....	14,802	19,053	15,396	17,612	6,758	6,082	520	2,400	.....
Arkansas	6,318	3,682	.....	10,140	9,100	.....	7,731	9,173	.....	3,000	80	.....
California	6,136	139	.....	14,196	152	.....	24,067	68	.....	11,000	.....	.....
Colorado	110	98,255	[3] 8,858	114	118,481	[3] 6,380	4,821	112,354	[3] 11,714	13,500	9,900	.....
Georgia	(2)	(2)	.....	3,614	13,281	.....	6,679	9,510	1,266	50	3,800	250
Minnesota	....	193,257	47,146	....	359,573	91,590	.....	630,827	229,869	.....	53,100	135,000
Montana	6,418	.....	.....	61,109	1,568	.....	199,982	.....	.....	27,300	.....	.....
Nevada	(2)	122,429	.....	3,450	122,872	.....	19,872	80,354	.....	80	98,000	1,020
New Mexico	(2)	16,068	.....	2,603	15,900	.....	3,126	32,907	400	.....	12,500	.....
Tennessee	429	.....	.....	1,996	83	.....	4,162	2,307	51	130	.....	.....
Texas	(2)	.....	.....	25	135	.....	380	.....	.....	.....	.....	.....
Utah	1,282	(2)	.....	4,195	136	.....	5,100	.....	.....	.....	.....	.....
Virginia	4,417	7,213	(2)	12,360	17,577	16,819	10,928	7,859	4,917	4,650	5,770	.....
Wisconsin	.....	.....	3,982	.....	.....	200,327	.....	.....	215,839	.....	.....	[4] 251,862
Undistributed	3,304	5,418	30,487	537	52,848	.....	750	23,603	.....	.....	31,530	.....
Total	31,474	453,853	90,473	129,405	730,759	[3] 330,512	305,869	916,163	[3] 470,138	60,270	217,080	[3] 388,132

[1] Mineral Resources and Geological Survey records. Figures represent ore shipped. Figures for 1919 are estimated by the Geological Survey.
[2] Included under "Undistributed."
[3] Includes small amounts under 5 per cent.
[4] Under 5 per cent manganese.

Imports of manganese alloys and quantities made from domestic and imported ores in the United States.[1]

[Long tons.]

	1913		1914		1915	
	Alloy.	Manganese.	Alloy.	Manganese.	Alloy.	Manganese.
Ferromanganese:						
Imported	128,070	102,456	82,997	66,398	55,263	42,210
Domestic production [2]	119,495	94,342	100,731	79,408	145,842	113,378
From domestic ore	[3] 1,075	[3] 850	[3] 1,978	[3] 1,408	[3] 1,946	[3] 1,568
From imported ore	[3] 118,420	[3] 93,492	[3] 98,753	[3] 78,000	[3] 143,896	[3] 111,810
Total	247,565	196,798	183,728	145,806	201,105	155,588
Per cent (manganese) as ferromanganese made from domestic ore	.....	0.4	.....	0.9	.....	1.0
Number of plants making ferromanganese	2	.....	5	.....	9	.....
Spiegeleisen:						
Imported	77	15	2,870	574	200	40
Domestic production [2]	106,990	20,845	76,625	15,732	114,446	23,638
From domestic ore	41,744	8,020	51,511	10,707	107,063	22,218
From imported ore	65,236	12,825	25,114	5,025	7,384	1,420
Total	107,057	20,860	79,495	16,306	114,646	23,678
Per cent (manganese) as spiegeleisen made from domestic ore	.....	38.5	.....	66.3	.....	93.8
Number of plants making spiegeleisen	4	.....	6	.....	7	.....
Total available supply of metallic manganese as alloys	.....	217,658	.....	162,112	.....	179,266
Per cent (total manganese) imported as alloys	.....	47.1	.....	41.3	.....	23.6
Per cent (total manganese) as ferromanganese made in United States from imported ore	.....	42.9	.....	48.1	.....	62.3
Per cent (total manganese) as spiegeleisen made in United States from imported ore	.....	5.9	.....	3.1	.....	.8
Per cent (total manganese) as ferromanganese made in United States from domestic ore	.....	.4	.....	.9	.....	.9
Per cent (total manganese) as spiegeleisen made in United States from domestic ore	.....	3.7	.....	6.6	.....	12.4
Per cent (total manganese) as alloys made from domestic ore	.....	4.1	.....	7.5	.....	13.2
Per cent (total manganese) made and imported as spiegeleisen	.....	9.6	.....	10.0	.....	13.2
Total, open-hearth and Bessemer steel	.....	31,145,637	.....	23,395,530	.....	31,966,315

[1] From manuscript copy Mineral Resources, 1918 (Geological Survey).
[2] Quantity made.
[3] Partly estimated.

Imports of manganese alloys and quantities made from domestic and imported ores in the United States—Continued.

[Long tons.]

	1916		1917		1918	
	Alloy.	Manganese.	Alloy.	Manganese.	Alloy.	Manganese.
Ferromanganese:						
Imported	90,928	72,742	41,969	33,575	26,906	21,[illegible]
Domestic production [2]	227,801	171,051	260,270	193,079	318,948	220,[illegible]
From domestic ore	17,172	12,845	29,813	23,152	80,308	57,324
From imported ore	210,629	158,206	230,457	169,927	238,640	163,447
Total	318,729	243,793	302,239	226,654	346,116	242,504
Per cent (manganese) as ferromanganese made from domestic ore	.....	5.3	.....	10.2	.....	23.6
Number of plants making ferromanganese	13	.....	23	.....	27	.....
Spiegeleisen:						
Imported	.....	.....	3,968	793	1,969	394
Domestic production [2]	184,822	40,151	199,024	44,323	273,952	54,[illegible]
From domestic ore	141,795	31,538	170,914	38,419	232,986	47,[illegible]
From imported ore	43,027	8,613	28,110	5,904	40,966	7,[illegible]
Total	184,822	40,151	202,992	45,116	275,921	54,[illegible]
Per cent (manganese) as spiegeleisen made from domestic ore	.....	78.5	.....	85.1	.....	85.0
Number of plants making spiegeleisen	11	.....	17	.....	18	.....
Total available supply of metallic manganese as alloys	.....	283,944	.....	271,770	.....	297,[illegible]
Per cent (total manganese) imported as alloys	.....	25.6	.....	12.7	.....	7.3
Per cent (total manganese) as ferromanganese made in United States from imported ore	.....	55.7	.....	62.5	.....	55.6
Per cent (total manganese) as spiegeleisen made in United States from imported ore	.....	3.1	.....	2.2	.....	2.5
Per cent (total manganese) as ferromanganese made in United States from domestic ore	.....	4.5	.....	8.5	.....	19.3
Per cent (total manganese) as spiegeleisen made in United States from domestic ore	.....	11.1	.....	14.1	.....	15.9
Per cent (total manganese) as alloys made from domestic ore	.....	15.6	.....	22.7	.....	35.2
Per cent (total manganese) made and imported as spiegeleisen	.....	14.1	.....	16.6	.....	18.3
Total, open hearth and Bessemer steel	.....	42,474,466	.....	44,628,853	.....	43,835,627

FOREIGN PRODUCTION.

Russia and India have for years been the leading manganese ore-producing countries, supplying around 80 per cent of the world's requirements. Brazil is also a large producer, normally supplying about 10 per cent of the world's output. Relatively little ore is used in these countries, most of it being sent to the large consuming countries of Europe and to the United States. The Indian ore has been used largely by Great Britain, but much of it has gone to the United States, France, and Germany.

Russia is the main source of high-grade ore for use in the chemical industries. The ore is of a fine, earthy nature, some of it running from 48 to 52 per cent manganese as it comes from the mine. Concentrate of exceptional purity, obtained by washing, contains 81 to 92 per cent of manganese dioxide and less than 1 per cent of iron. Some of the ore is used in paint and pottery industries, and a high-grade concentrate goes into the manufacture of dry batteries and flint glass.

Although the main advantage of the Russian ore is its purity, by far the larger part of it is used in the iron industry. As a general rule the ore exported has been sorted and will average 50 to 51 per cent manganese, about 0.16 per cent phosphorus, and not over 10 per cent silica.[4]

The manganese deposits of the Caucasus region are of extraordinarily high grade and have as yet been hardly tapped. Had it not been for the advent of the war, the output in 1914 from this region alone would have been 1,300,000 tons. There are some serious practical objections to the fineness of the Caucasian manganese ore. The material has in general a slightly higher manganese content than the Indian ore and an extremely low iron content. Shipments over long periods have averaged only 0.43 per cent iron. They are also low in phosphorus and the percentage figure of 0.175 phosphorus is practically a maximum.

The Caucasian situation has been much upset since the war because of lack of shipping in the Black Sea, the disorganization of the Tschiatouri Railway, and labor and political difficulties. There was practically no production in 1918 and 1919, and it is stated that much of the concentrate produced since 1914 has been insufficiently washed. Miners' wages in January, 1920, were said to be equivalent to $4 per day at existing exchange. In terms of the depreciated local currency this is an enormous wage and there is little prospect of the miners agreeing to take less. The mines are now reported to be under strict control of the Georgian government which regulates prices through an association comprising the British as well as the native mine owners. In April, 1920, 100s. per ton, on a 50 per cent base with a unit variation of 1s., was quoted. This price corresponded to about 60 cents a unit delivered at Atlantic seaboard or 20 cents less than prevailing prices. Shipments are now only by way of Poti and, owing to shallow water in that harbor, are limited to 3,000 tons. Business is further hampered by the practical absence of bottoms and the risk of irregular silica content complicated by the necessity of paying 80 per cent of the purchase price against miner's analysis on bill of lading.

The manganese resources of Brazil are said to be rapidly diminishing.[5] In the State of Bahia the deposits appear to be superficial, small, and very irregular. In the State of Minas Geraes, whence comes most of the Brazilian ore, manganese oxides persist to a depth of 410 feet. The area is 2,500 feet long by 1,000 feet wide, and contains reserves approximately between 7,000,000 and 10,000,000 tons. During the war the great Morro da Mina mine, of Minas Geraes, was intensively worked, and the grade of ore has fallen off (from the old

[4] U. S. Steel Corporation.
[5] D. F. Hewett.

standard of 48 to 50 per cent) until now anything over 40 per cent is acceptable. Other deposits of manganese ore are reported in the States of Maranhao and Matto Grasso.

Germany, Austria-Hungary, Japan, and Spain produce relatively small quantities of manganese ore. That produced by Germany and Austria-Hungary is used in their domestic industries. Japanese and Spanish ore is in a large part exported. The Japanese material rivals the Russian product in purity, and is an important source of manganese for battery and chemical purposes.

Extensive manganese deposits were discovered about 1910 in Egypt and a reserve of 15,000,000 tons is reported in sight, much of it high grade. The district is in Sinai, situated 12 miles from the Red Sea coast with which it is connected by railroad and aerial tram. A mechanical loading system is installed at the docks, of a capacity of 600 tons per day. The iron content of the Sinai ore is higher even than that of the Indian ore and it has been difficult to obtain ferromanganese from this material of better than 60 per cent grade. Operations were suspended during the war, but it is possible that this deposit is to be a factor of some importance in the world ore market.

In 1915 Cuba became a producer of manganese ore and one of special importance to the United States, on account of its close proximity to our eastern seacoast. Cuba produced 9,000 tons in 1915, a quantity about equal to that produced by the United States; and 33,120 in 1916, an amount slightly greater than the United States production. The Cuban ore is of even lower grade than the ores of this country.

Production of manganese ore in principal foreign countries.[1]

[Long tons.]

Country	1912	1913	1914	1915	1916	1917	1918
Canada	67	.....	25	180	855	131	[illegible]
Cuba	.....	.....	.....	9,000	33,120	41,651	81,999
Brazil	152,431	120,368	180,738	284,111	495,172	524,436	345,879
Austria	12,275	16,280	(2)	(2)	(2)	(2)	(2)
Bosnia and Herzegovina	4,577	5,709	4,055	[7] 10,600	[7] 23,000	[7] 49,500	(2)
France	5,488	7,610	(2)	(2)	(2)	(2)	(2)
Germany	91,018	748	(2)	(2)	(2)	(2)	(2)
Greece	7,595	549	.....	[7] 408	[7] 3,650	(2)	(2)
Hungary	10,662	18,706	(2)	(2)	(2)	(2)	(2)
Italy	2,599	1,506	1,673	12,379	17,960	[7] 24,900	(2)
Russia	911,742	1,289,370	[7] 98,500	[3] 8,705	[7] 288,000	(2)	(2)
Spain	17,126	21,254	12,947	14,102	13,954	56,556	(2)
Sweden	5,082	3,938	3,585	7,487	[7] 9,000	[7] 20,200	(2)
United Kingdom	4,170	5,393	3,437	4,640	5,140	9,942	[7] 17,456
India	633,080	815,047	682,898	450,416	654,204	590,813	(2)
Japan	11,862	18,016	16,807	25,400	7,749	(2)	(2)
Africa	.....	.....	.....	1,437	[4] 1,995	[4] 5,831	.....
Australia	328	27	[7] 26	[7] 1,260	[7] 3,236	[7] 4,056	198
All other [5]	.....	.....	.....	.....	[6] 12,870	[6] 20,701	[6] 28,870

[1] U. S. Geological Survey, Mineral Resources, 1917-18.
[2] Not yet available.
[3] Exports.
[4] Shipments from Gold Coast not included. July 1916 to November, 1917, 28,465 tons
[5] Includes Mexico, Porto Rico, Costa Rica, Panama, Argentina, Chile, Ecuador, Peru, and China.
[6] Imports into United States, production not available.
[7] Compiled from original sources by National (British) Federation of Iron and Steel Manufacturers.

TRANSPORTATION.

The greater part of the imported ore goes to consumers over comparatively short distances by rail from the entry ports of Baltimore and Philadelphia. One large consumer—of Cuban ore chiefly—located at Sparrows Point, Md., unloads the ore directly from vessel to plant.

Most of the Russian ore has come from the district of Tschiatouri over from 90 to 126 miles of railroad to the ports of Poti and Batum on the Black Sea. Much of the Russian ore imported into the United States before the war (1914–1918) was transshipped from England and Germany.

Most of the ore mines of British India are located on railways, although some of the ore is carted from the mine to the railroad over distances varying from 1 to 20 miles and then transported by rail from about 130 to 700 miles to the shipping ports Bombay, Calcutta, Madras, or Goa. Freight rates from the mines to Bombay during the war period remained practically constant at 8 rupees per ton, but these were increased on January 1, 1920, to 10 rupees ($4.24).[a]

The bulk of the ore exported from Brazil is mined from 283 to 310 miles from the shipping port of Rio de Janeiro, to which it is transported from the mines by rail.

The ore of Cuba comes chiefly from the Province of Oriente, much of which must be transported in carts or automobiles from 3 to 15 miles to the railroad. The ore has only a short distance to travel by rail to the ports of Santiago and Nipe, from which it is shipped to the United States.

IMPORTS.

Before the outbreak of hostilities in Europe (1914) the United States received nearly all of its foreign manganese ore from three countries—British India, Brazil, and Russia. In the fiscal year 1914, the last normal year before the war, these three countries supplied 99 per cent of the total imports, divided as follows: British India 40 per cent, Brazil 25 per cent, and Russia 34 per cent. After 1915, because of war conditions, imports from Russia stopped and the quantity received from British India was greatly reduced; consequently imports from Brazil began to show large annual increases.

In 1915 Cuba began mining manganese ore, the industry being promoted by American interests and the entire production sent to the United States. The quantity imported from Cuba increased from 5,141 tons in 1915 to 82,974 tons in 1918, an amount equal to one-sixth of our total imports.

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[a] With rupee exchange at 2/4½ d., and sterling $3.50.

Imports of manganese ore by countries.[1]

Country.	1910		1911		1912		1913	
	Quantity.	Value.	Quantity.	Value.	Quantity.	Value.	Quantity.	Value.
	Long tons.		*Long tons.*		*Long tons.*		*Long tons.*	
Russia	33,120	$269,717	19,103	$186,590	83,334	$490,306	124,337	$712,334
India	140,965	682,897	106,580	501,746	128,645	644,162	141,587	710,[illegible]
Brazil	53,750	544,353	41,600	342,769	81,580	510,300	70,200	445,6[illegible]
Undistributed	14,513	214,164	9,569	155,686	7,102	124,416	8,966	161,65[illegible]
Total	242,348	1,711,131	176,852	1,186,791	300,661	1,769,184	345,090	2,029,6[illegible]

Country.	1914		1915		1916	
	Quantity.	Value.	Quantity.	Value.	Quantity.	Value.
	Long tons.		*Long tons.*		*Long tons.*	
Australia					488	$19,313
Belgium	450	$5,913				
Brazil	113,924	736,769	275,579	$2,240,837	471,837	7,139,[illegible]
India	103,583	504,981	36,450	194,626	51,960	401,[illegible]
Canada	64	1,357	325	12,989	756	72,[illegible]
Chile						1[illegible]
Cuba			5,141	69,453	30,563	514,1[illegible]
Central America[2]					12,132	311,[illegible]
France	5	1,580				
Germany	1,713	92,273	258	23,590		1[illegible]
Greece					3,000	24,31[illegible]
Japan	40	1,320	2,810	106,434	5,196	163,[illegible]
Netherlands	2,505	52,213	50	1,792		
Portugal					289	11,99[illegible]
Russia	52,681	490,331				
United Kingdom	8,321	136,206	49	4,730	100	7,17[illegible]
All other	8	1,177	116	1,529		[illegible]
Total	283,294	2,024,120	320,778	2,655,980	576,321	8,666,17[illegible]

Country.	1917		1918		1919	
	Quantity.	Value.	Quantity.	Value.	Quantity.	Value.
	Long tons.		*Long tons.*		*Long tons.*	
Argentina	6,600	$40,023	849	$39,127	2,305	$86,547
Australia			198	13,990	548	26,[illegible]
Brazil	512,517	8,578,296	345,877	10,174,138	246,592	7,077,071
India	48,975	362,582	29,275	547,886	9,200	254,971
Canada	883	40,534	301	11,968	582	16,[illegible]
Chile	202	6,330	2,998	48,760	441	13,[illegible]
Cuba	44,511	612,413	82,974	2,751,193	35,320	1,433,[illegible]
Central America[2]	12,710	384,511	20,538	712,730	16,285	617,63[illegible]
Japan	2,745	85,538	[3] 3,709	177,246	651	39,[illegible]
Portugal					400	31,100
Russia					6,916	296,915
United Kingdom	805	152,084	4,362	612,638	9,470	1,066,741
All other	24	618	222	6,191	4,634	268,737
Total	629,972	10,262,929	491,303	15,095,867	333,344	11,229,184

[1] Calendar years.
[2] Includes Mexico, Panama, and Costa Rica.
[3] Includes 3,000 tons from China.

Grades and kinds.—Nearly all of the ore used in the manufacture of dry batteries and in the chemical industry has come from Russia. Most of the ore imported from Russia, however, goes into steel making. A much smaller supply of chemical ore of similarly high purity is also imported from Japan.

Twenty analyses of manganese ores from 10 districts of British India showed the following ranges in percentage composition: Manganese, 30 to 58.64; silica, 1 to 18.48; and phosphorus, 0.01 to 0.65. The average analysis, in percentages, was: Manganese, 49.13; silica, 5.43; and phosphorus, 0.18.[6]

Brazilian ores from the Lafayette and Bahia districts showed in 10 analyses: Manganese, 43 to 55.14 per cent; silica, 1 to 7 per cent; and phosphorus, 0.01 to 0.15 per cent. The average analysis was: Manganese, 50.82 per cent; silica, 2.68 per cent; and phosphorus, 0.057 per cent.[7]

Ores of the great Morro da Mina mine, formerly averaging between 48 and 50 per cent manganese, have fallen off to an average of 45 per cent, or less.

Import restrictions.—The American Iron and Steel Institute acted as consignee for all manganese (including ore and ferromanganese) from December 15, 1917, until February 20, 1919. Transoceanic shipments were greatly restricted, and after July 19, 1918, even Asiatic ore was practically cut off until January, 1919, when the importation of manganese ore was permitted from any non-enemy country.

Distribution in United States for consumption.—Most of the foreign manganese ore enters the United States through the ports of Baltimore and Philadelphia, whence it is distributed largely to the various ferromanganese furnaces of Maryland and Pennsylvania. Some Cuban and South American ore consigned to Southern furnaces is landed at Mobile and Pensacola.

Persistence.—Up to 1916 imports of manganese ore varied but little from year to year. In that year war demands caused marked increases in import tonnage. This movement reached its height during 1918. Imports in 1919 were little above the prewar figure. The insufficient home production of high-grade ore and the more uniform quality of the foreign ore are the factors responsible for the steady importation.

Imports for consumption (free).

MANGANESE, OXIDE AND ORE OF.

Fiscal year.	Quantity (long tons).	Value.	Value per unit of quantity.	Fiscal year.	Quantity (long tons).	Value.	Value per unit of quantity.
1907	205,295.86	$1,672,654	$8.15	1914	288,837.00	$1,841,472	$6.37
1908	218,568.42	1,773,018	8.11	1915	206,913.00	1,494,965	7.23
1909	165,059.75	1,243,657	7.53	1916	492,967.00	5,358,087	10.87
1910	247,226.63	1,594,425	6.45	1917	656,026.00	10,542,572	16.07
1911	209,566.80	1,453,177	6.93	1918	557,711.00	11,944,515	21.42
1912	197,959.81	1,292,435	6.53	1919	473,202.00	16,358,741	34.57
1913	407,168.99	2,196,565	5.39				

[1] Harder, E. C.: U. S. Geological Survey.

ton unit (22.4 lbs.) specifying the approximate manganese, silica, and phosphorus limits; they are usually oxide but may contain a certain amount of carbonate or silicate. Chemical ore is pyrolusite (MnP_2) low in iron and is quoted in dollars per long ton. Chemical and Metallurgical Engineering (July 21, 1920) quotes metallurgical ore (50 per cent Mn) at 85 to 90 cents per unit (equivalent to $42.50 to $45 per ton) and chemical ore at $75 to $85 per ton; the price differential is not stable, but chemical ore always sells at fully 50 per cent and frequently up to 100 per cent above metallurgical ore having practically the same manganese content.

The annual average prices given below are the averages for domestic ore of varying grades, f. o. b. mines and reflect the low grade of the material.

Average wholesale prices of manganese ore.[8]

[Per long ton of domestic ore at mine.]

1910	$10.14	1915	$11 67
1911	10.01	1916	23.24
1912	9.45	1917	28.00
1913	10.00	1918	35.00
1914	10.39		

Government price fixing was a factor in the latter part of 1918. Previous to that the schedule of the Carnegie Steel Co., of Pitts-

[8] Mineral Resources, U. S. Geological Survey.

burgh, Pa., was the standard of value. The specifications were based on ore containing not over 8 per cent silica and not more than 0.25 per cent phosphorus. Excess of these impurities above these limits is penalized. In general, very little ore containing more than 25 per cent silica can be used, and over 12 per cent is heavily penalized (e. g. Cuban ore).

The fluctuations in the prices of foreign ore are reflected fairly accurately in the statistics of imports. The prices show a gradual fall down to a minimum of only a little more than $5 a ton in 1913, followed by rapid rise during the war period. Prewar statistics of manganese ore prices in foreign countries have not been obtained, but they are known to have been much lower than in the United States. Since the war, however, England is the only important foreign consuming market. The disorganization of shipping has resulted in English consumers losing much of their former advantage as regards cheap freights and manganese ore prices in that country, since the war, have not varied widely from American prices and have occasionally gone higher.

TARIFF HISTORY.

Manganese ore has been exempt from duty since 1872. Foreign countries generally also admit it free of duty.

Rates of duty.

MANGANESE, OXIDE AND ORE OF.

Act of—	Par.	Tariff classification or description.	Rates of duty.
1883.....	621	Manganese, oxide and ore of.....	Free.
1890.....	643	.....do.....	Do.
1894.....	546	.....do.....	Do.
1897.....	607	.....do.....	Do.
1909.....	619	.....do.....	Do.
1913.....	540	.....do.....	Do.

COURT AND TREASURY DECISIONS.

There have been many decisions upon what constitutes manganese ore for tariff purposes. In 1879 the Treasury Department held that to be dutiable as manganese ore the commodity must contain 50 per cent or more of manganese and not more than 10 per cent of iron. (Dept. Order, T. D. 4114; followed in T. D. 7273.)

An importation containing less than 50 per cent of manganese but not more than 10 per cent of iron, but commercially known as manganese ore and valuable only for the manganese content was, however, held entitled to free entry either as manganese ore or as an unenumerated article similar thereto. (Appeal, T. D. 9954.)

Ore containing from 48 to 51 per cent of manganese and from 1 to 2 per cent of iron was held entitled to free entry as manganese ore. (Dept. Order, T. D. 16550.) These percentages were next changed to 40 to 50 per cent or more of manganese and less than 10 per cent of iron. (Dept. Order T. D. 19184.)

A product recoverable from manganese after use in the manufacture of chlorine was held exempt from duty as oxide of manganese. (Appeal, T. D. 8429.)

Oxide of manganese, classified as a chemical compound, was held entitled to free entry under the specific provision therefor in the act of 1909. (Abstract 35681, T. D. 34468.)

Merchandise, invoiced as Braunstein Grob, consisting of a chemical mixture composed of manganese oxide and about four-tenths of 1 per cent of nickel oxide, was held exempt from duty as oxide of manganese and not dutiable as a chemical mixture under the act of 1909, nickel oxide being declared naturally present. (Abstract 36912, T. D. 34933.)

COMPETITIVE CONDITIONS.

During the war period, the production of manganese ore in the United States was a profitable industry in many localities, but only because prices were from three to four times those existing prior to the outbreak of hostilities in Europe. With the return of prewar conditions the industry must compete again with the high-grade cheap foreign ores.

Foreign ores are of better average grade and more easily mined than the domestic deposits. The average grade of imported ore is from 45 to 55 per cent manganese as compared to domestic "high grade" running from 35 to 45 per cent. It is a significant fact that most of the American mines are situated in localities remote from the points of consumption, often at considerable distances from the railroad.

Typical analyses (dry) of the manganese ores used in the manufacture of ferromanganese by the United States Steel Corporation (1920) are:

Kind of ore.	Manganese.	Iron.	Silica.	Phosphorus.
	Per cent.	*Per cent.*	*Per cent.*	*Per cent.*
Brazilian	46.84	4.80	5.00	0.091
Indian	51.60	5.89	6.52	.095
Caucasian	50.00	1.25	9.00–10.25	.17
Domestic (average of best quality)	40.75	3.38	12.21	.065

Until the dislocation of shipping as a result of the submarine menace, it was generally believed that domestic mines could not furnish any large tonnage of manganese. The record of production disproves this impression, but the domestic industry was developed

only under extraordinary conditions, high prices, and practically complete freedom from foreign competition. The war disturbance also fostered production in Cuba, and gave rise to a mushroom industry in other countries that had not hitherto been able to develop any important output as long as shipments from India, Russia, and, to less extent, Brazil were unrestricted. Costs in all districts increased greatly, but nowhere did they increase as much as in the United States.

RESERVES.

Domestic reserves of manganese ore, exclusive of those in Butte, are sufficient for only a few years. The amount of high-grade ore (35 per cent or more) in sight has been estimated at only 699,750 tons, with 1,130,000 tons more in prospect.[9] Taking the normal consumption in this country as 350,000 tons, these reserves would be exhausted in from two to five years.[10] There are large reserves in the Butte district but to date there are no reliable figures as to the exact tonnage available. These deposits together with the Philipsburg ores are the only ones in the United States which could serve as the basis for a permanent industry.

Russia, India, and Brazil have very large deposits of manganese ore. The reserves of the Tschiatouri and Nicopal districts in Russia are estimated at 117,400,000 tons. Three districts in India have reserves of 11,137,000 tons, while the reserves of two mines (Wigg and Morro da Mina) of Minas Geraes, Brazil, are 7,000,000 tons.[11] This ore is all much higher grade than that of the domestic deposits. Other countries have less important supplies.

COSTS.[12]

Domestic.—The average cost of producing clean manganese ore (containing 35 per cent or more manganese) in the United States during 1918 was $16 per long ton f. o. b. mine. To this must be added the freight to the furnace and war taxes.

These items ranged from $3.50 to $13.50 per ton according to the locality. A fair average of the cost of ore delivered at the furnace (Chicago) from the four principal producing States during that period is $26.80 per long ton, or, based on the average manganese content of 40 per cent, $0.65 per unit of metal content.[13]

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[9] U. S. Geological Survey, December, 1918.

[10] On basis of an annual production of 45,000,000 tons steel domestic consumption of manganese ores is about 350,000 tons. The reserves in known deposits therefore are only available for one or possibly two or three years.

[11] Harder, E. C.: Manganese Ores of Russia, India, Brazil, and Chile, 1916.

[12] A detailed study of domestic, Brazilian, and Cuban costs by W. R. Crane of the U. S. Bureau of Mines is in the Tariff Commission files and has been drawn upon freely for the text and figures presented in this section.

[13] This average includes many small mines. At chief points of production in Montana (the main domestic field)—namely, Butte and Philipsburg—a cost considerably less than this would be shown. It is claimed by Anaconda Copper Mining Co. that if industry were on a more permanent basis, cost would reduce to $10 or $12 per ton.

Summarized data on estimated average cost of domestic ores.

Kind of ore.	Estimated tons produced in 1918.	Estimated cost on railroad car.	Estimated railway freight.	Total estimated cost delivered.	Manganese per cent.	Estimated cost per unit[1] (cents)
Carbonate	63,000	$5.00	$11.35	$16.35	36.5	45.0
Oxide	231,500	19.00	10.70	29.70	41.0	72.7
Average	[2] 294,500	16.00	10.85	26.80	40.0	65.8

[1] 22.4 pounds manganese metal content.
[2] Later production figures show total of 305,869 tons.

There are of course a number of favored districts which could produce oxide ores more cheaply than the average figures given above. Virginia, for instance, probably delivered ore to the furnaces at a cost of about 55 cents per unit. Cartersville (Georgia) and Batesville (Arkansas) ores should have reached Birmingham, Chicago, or Pennsylvania furnaces for 55 to 60 cents per unit. Nearly 85 per cent of the oxide ores, however, came from the far Western States and were subject to high railway freights. The carbonate ores paid a high railway freight, but other costs were so low that these were probably the cheapest ores produced either on a ton or unit basis.

Cost of manganese ore delivered at furnace under war conditions—United States.[1]

	Estimated cost f. o. b. railway cars.	Estimated freight to furnace.	Total cost delivered furnace.	Average per cent manganese.	Estimated cost per unit of manganese.
Alabama	$12.00	$7.50	$19.50	40	$0.50
Arizona	14.00	11.00	25.00	41	.61
Arkansas	17.50	5.00	22.50	41	.55
California	12.00	13.00	25.00	43	.58
Georgia	15.00	7.50	22.50	40	.56
Montana:					
Butte	5.00	11.00	16.00	37	.43
Philipsburg	15.00	11.00	26.00	42	.62
Nevada	12.00	12.00	24.00	42	.57
New Mexico	14.00	10.00	24.00	42	.57
Tennessee	22.50	6.00	28.50	40	.71
Utah	14.00	11.00	25.00	43	.58
Virginia	15.00	3.50	18.50	42	.44

[1] Crane, W. R.: Cost of Manganese Production in the United States, U. S. Bureau of Mines.

FUTURE COSTS.

The average costs shown above are for war times and more particularly for the last six months before the signing of the armistice.

In estimating future costs there is little to be gleaned from these war figures. Only small amounts of domestic ores were mined prior to the war, and these were frequently produced in a small way by farmers at such times when they and their teams were not busy with

farm work. The production was in the Southeastern States where freight rates to consuming centers were not excessive. Probably only small profits were made, but these were satisfactory under the circumstances. Costs were from $4 to $8 per ton on board railroad cars, but these figures are not fair guides to future possibilities.

Aside from railway freights, the wage scale enters more largely into the cost of production than any other single item. It has been thought probable by the Bureau of Mines that as the industries return to a peace basis, wages will decrease to some extent. Better practice should account for some reduction, and cost of supplies may perhaps be properly expected to drop in proportion to reduction in wages. The following table is based on a reduction in costs of 25 per cent:

Revised estimated average cost data on domestic manganese ores.[1]

Kind of ore.	Estimated proportionate tonnage per cent.	Estimated cost on railroad cars.	Estimated railway freight.	Total estimated cost delivered.	Manganese per cent.	Estimated cost per unit (cents).
Carbonate	21	$3 75	$11 00	$14 75	36 5	40.4
Oxide	79	14 25	10 40	24 65	41.0	60 0
Average	100	11.72	10 53	22.25	40 0	55.6

[1] U. S. Bureau of Mines, W. R. Crane.

Here again in certain more favored districts, as regards freight rates to consumers, the oxide ores can undoubtedly be delivered to the furnaces for less than 60 cents per unit. Southern States generally should reach 50 cents per unit or better. The Western States, on the other hand, will hardly be as low as 60 cents. The Butte carbonate ores are the one exception in the far West, owing to large-scale production and low-hauling costs.

FOREIGN PRODUCTION.

The principal source of foreign ore during the war was Brazil. The next most important single source was Cuba. Smaller amounts came from other points in the West Indies, Central and South America and the Orient, chiefly India.

In prewar times Russia and India were more important sources than Brazil. It seems probable, however, that Russia will not for a few years become a large factor, and that the Indian output may also be slow in reaching this country in volume. It is possible that English ferromanganese made from Indian ores may appear before long in quantities sufficient to affect the market. However, freights from India to the eastern seaboard of the United States early in 1920 are practically as favorable as to London. A recent isolated

shipment carried a freight rate of 80 shillings per ton, and the material was laid down in New York at a total cost of 60 cents per unit, or practically the same price at which it is sold in Great Britain. In 1913, at normal freights, Indian ore was delivered in the United States at from $11 to $16 per long ton, 49 per cent manganese content, or 31 cents per unit. Russian ore in 1913, of 52 per cent manganese content, was delivered for $12.46, or 24 cents per unit.

Our more immediate concern is with Brazilian and Cuban ores. Some information regarding costs in these countries is at hand and will be reviewed in the following pages.[14]

Cuba.—Manganese mining in Cuba is generally by open-cut methods. In only one instance has there been anything approaching true underground work. Preparation for market is generally by hand cleaning, though log washers are used at the most important mine in the island. One concentrator, involving screens and jigs, was built and operated during the war.

Reported ore costs in Cuba.

Mining and treatment	$5.00–$8.00
Hauling to railroad	2.00–12.00
Cuban railroad freights	1.00– 2.50
Port costs and charges	.75– 1.50
Royalty	1.50– 2.50

The two largest producers in Cuba were situated, as regards the bulk of their output, directly on the railroad or on tram lines leading to the railroad. The total cost of ore at the ship is taken as $14 per ton, including the above items and some further miscellaneous and general charges. No amortization of investment is included in this figure.

Cost data computed from four operations in Brazil.

Item.	A.	B.	C.	D.
Mining, f. o. b. cars	$5.00	$4.00	$5.00	$5.00
Export tax	1.85	1.85	1.90	1.85
Railway freight rate to Rio de Janeiro	1.50	1.50	[1] 5.35	5.40
Dockage at Rio de Janeiro	.65	.65	.....	.....
Lighterage at Rio de Janeiro	.....	.....	2.50	2.50
Transfer from narrow to broad gauge railroad	.....	.....	.25	.25
Haulage to station	.....	.....	.....	2.50
Total	9.00	8.00	5.00	17.50

[1] Mines C and D are handicapped by increased freight rates. The other two companies are still operating under old contracts.

In addition to the above figures a State tax of $3.20 was imposed during the war. Further, royalty charges up to $1.75 per ton were not uncommon. The total range of costs for Brazilian ore into ship would therefore be $12 to $22.50 per ton. Since the low cost is for one of the largest and most important mines, it is probable that a weighted average would be approximately $15.

[14] Crane, W. R.: U. S. Bureau of Mines.

OCEAN FREIGHT RATES.

Freight rates on manganese ores from Brazil, Cuba, and India, to the United States and England, are given below:

Prewar, India to the United States	$4.32
Prewar, India to England	3.84
Prewar, Brazil to the United States or England	2.88
Prewar, Cuba to the United States	1.50– 2.50
1916, Brazil to the United States	5.50– 6.50
1918, Brazil to the United States	15.00
1918, Cuba to the United States	9.50
1919–20, India to the United States	11.50–15.50
1919–20, India to England	11.50–15.50
1920 (April), Russia to United States	8.00–12.00
1920 (April), Russia to England (estimated)	20.00

The average rail freight during the war from Atlantic seaboard to consumer was approximately $3 per long ton.

SUMMARY OF COST OF FOREIGN ORES.

Assembling the foregoing figures we have a total estimated average cost for ore delivered at the furnace (Pittsburgh) in 1918 of $23.50 for Cuba and $30 for Brazil. On a unit basis this would be 62 cents for Cuba (for ore containing 38 per cent manganese) and 67 cents for Brazil (for ore containing 45 per cent manganese).

FUTURE FOREIGN COSTS.

Before the European war such ore as was shipped from Cuba was of a higher grade than that mined during the war, and was sold at the Atlantic seaboard for $10 to $12 per ton, or for, say, $8 to $10 per ton into ship at a Cuban port. This was very close to the average cost at that time. It is not likely that this Cuban cost will drop in the future much below $11 to $12, but it is certain that ocean freights will drop materially.

On this assumption we may expect to see Cuban ores reach the United States Atlantic seaboard in the not remote future at a cost of about $13.50, or, say, $16.50 delivered at the furnace. The quality of the ore, in order to be salable, will have to be better than it was during 1918. If it contains an average of, say, 41 units of manganese, the estimated future cost delivered at furnace becomes 40 cents.

The Brazilian problem is somewhat more complicated, as it is uncertain what will be done by the Brazilian Federal and State Governments with regard to the present high taxes. Other Brazilian costs will probably not be much reduced. If we assume that the

taxes, which in 1918 amounted to practically $5, are reduced two-thirds, the estimated average cost of $15 becomes $11.67 or say $11.50, to include some possible slight reduction in other directions.

It is interesting to compare this estimate with the selling price of Brazilian ores at Rio de Janeiro in former years, which were as follows:

Selling prices of Brazilian ores at Rio de Janeiro, 1914–1918.

Year.	Selling price per ton, reis.	Approximate equivalent
1914	22,000	$ 6
1915	29,000	[illegible]
1916	55,000	21
1917	93,000	25
1918	117,000	32

The real difference in the future will come in the matter of ocean freights. If these drop to somewhere nearly their former level, it should be possible to deliver Brazilian ores to the United States consumer for approximately $18.50. This figure includes $13.50 for cost into ship at Rio de Janeiro, $3 ocean freight, $1 for insurance, and $3 for United States rail freight to the furnace.

Brazilian ores reaching this country were formerly of higher grade than those imported during the war. If the grade now improves slightly, say, to 46 per cent manganese, the estimated average future unit cost becomes 40 cents.

Thus it is seen that it may fairly be expected that both Brazilian and Cuban ores can before long be delivered to the United States consumer for about 40 cents per unit. At an equal price, Brazilian ore will always have the preference owing to the higher content of metallic manganese. Cuban ore generally carries 12 per cent or more of silica and is less desirable, as it is more costly to smelt.

COMPARISON OF DOMESTIC AND FOREIGN COSTS.

The estimated average costs for manganese ores, per long ton delivered to the consumer, are compared in the following table:

Estimated average costs of manganese ores delivered to the consumer during 1918 and the future.[1]

	Estimated average cost during	Estimated average cost in the

[1] U. S. Bureau of Mines, W. R.

This comparison indicates that the oxide tage in competition with foreign ores, eve ocean freights. Had foreign ores moved

FREIGHT RATES.

In August, 1918, Director General of Railroads, W. G. McAdoo, announced new rates on manganese ore which were lower than those previously prevailing. The rates apply to shipments in carload lots per net ton, minimum carload weight 60,000 pounds. To Chicago: From Colorado and New Mexico, $7; Montana, $8; Arizona, $9; Nevada, $10 and $11; Oregon, Washington, and California, $11. To Atlantic seaboard: From Colorado and New Mexico, $9.50; Montana, $10.50; Arizona and Utah, $11.50; Nevada, $12.50 and $13.50; Washington and California, $13.50; Oregon, $13.50. These rates were in effect until August, 1920, when a general freight increase was made by the Interstate Commerce Commission. Existing rates in the southern group, consisting of lines in the territory lying south of the Ohio River and east of the Mississippi River were increased 25 per cent, with a 40 per cent increase applying to those in the western group. In the western group, which consists of the lines in the territory west of Chicago and east of the Montana-North Dakota State line and east of Denver, Colo., a 35 per cent increase was allowed and in the mountain Pacific group, covering lines in the territory west of the Montana-North Dakota State line, a 25 per cent increase. These percentages of increase apply within the groups mentioned only. Where joint rates are in effect from one group to another the increase is 33⅓ per cent.

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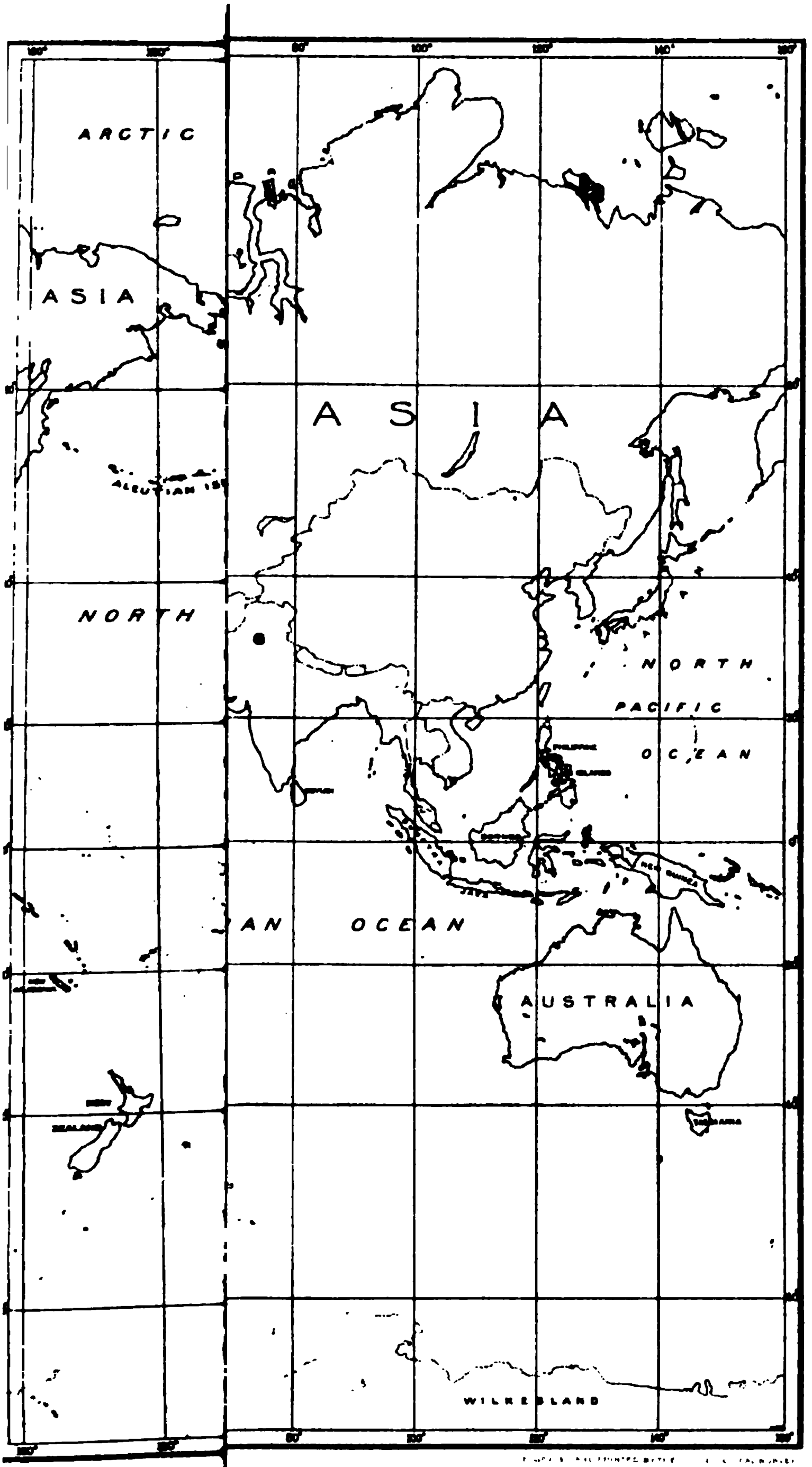
POTASH



THE WORLD

Potash in th[illegible]es, and cement mills; Utah—Alunite, Salduro Salt Marsh, and [illegible]stillery waste; Massachusetts—Wool washings; Wisconsin—Wo[illegible]distillery wastes; and New Jersey—Glauconite (greensand)

U. S. G[illegible] S[illegible]

in about 10 years at the rate of the 1918 production. Searles Lake, in California, is estimated to contain as much as 20,000,000 tons of actual potash.

Domestic Supplies.

For several years before the outbreak of the war the imports of potash salts averaged about 1,000,000 tons. This quantity represented a normal prewar consumption of approximately 270,000 short tons of actual potash (K_2O). Over 99 per cent of this import came from Germany.

The domestic supplies of potash during the war have originated from many varied sources and by different processes. The source which gives the greatest promise of permanency under competitive conditions is the dust from cement mills. The collection of the dust abates a nuisance and gives a valuable by-product. If practiced by all cement mills it is probable that 75,000 tons of actual potash could be obtained annually, or nearly one-third of the prewar consumption.

The collection of potash from the dust of blast furnaces, although the commercial recovery has not been developed to the same extent as in the case of cement dust, offers a possible permanent source of potash. Apparently only the Southern and imported Cuban iron ores contain sufficient potash to make its recovery on a commercial scale feasible. A production of 20,000 tons of actual potash from this source may be possible.

It is questionable if the recovery of potash on the present scale from the natural brines of Nebraska and California, from kelp, and from the leucite hills of Wyoming, can be continued after the resumption of foreign competition. The raw materials are not as suitable for cheap production of potash as are the minerals of the Stassfurt and Alsace deposits. The sources are far from the chief markets (South Atlantic States), which places them at a large disadvantage in regard to freight rates.

Many of the other processes for recovering potash are still largely in an experimental state.

THE POTASH INDUSTRY.

THE SITUATION BEFORE THE OUTBREAK OF THE WAR.

The salts of potash and of soda are so similar that for nearly all urposes except fertilizer one can be substituted for the other. In ıany cases the soda salt is both better and cheaper. In others, the otash salt is used because it has an advantage sufficient to counter-alance the prevailing difference in price. Until about 1800, potash ras obtained entirely from wood ashes. It was cheaper and more lentiful than soda, then obtained exclusively from the ashes of eaweed. Glass and soap made at that time were chiefly potash lass and potash soap. The development of the Leblanc process for ıaking soda from salt during the first quarter of the nineteenth entury made soda cheaper than potash, and the result was that the onsumption of soda increased more rapidly than that of potash. ıbout 1857 large deposits of soluble potash salts were discovered nderlying an extensive area in central Germany. In 1860 the sefulness of these salts as fertilizer was discovered, and in 1861 the irst factory for refining the crude salts was erected.

The rapid growth of the industry is shown by the following figures or the output of the German mines. Germany's sales of pure potash re shown graphically in the figure on page 156.

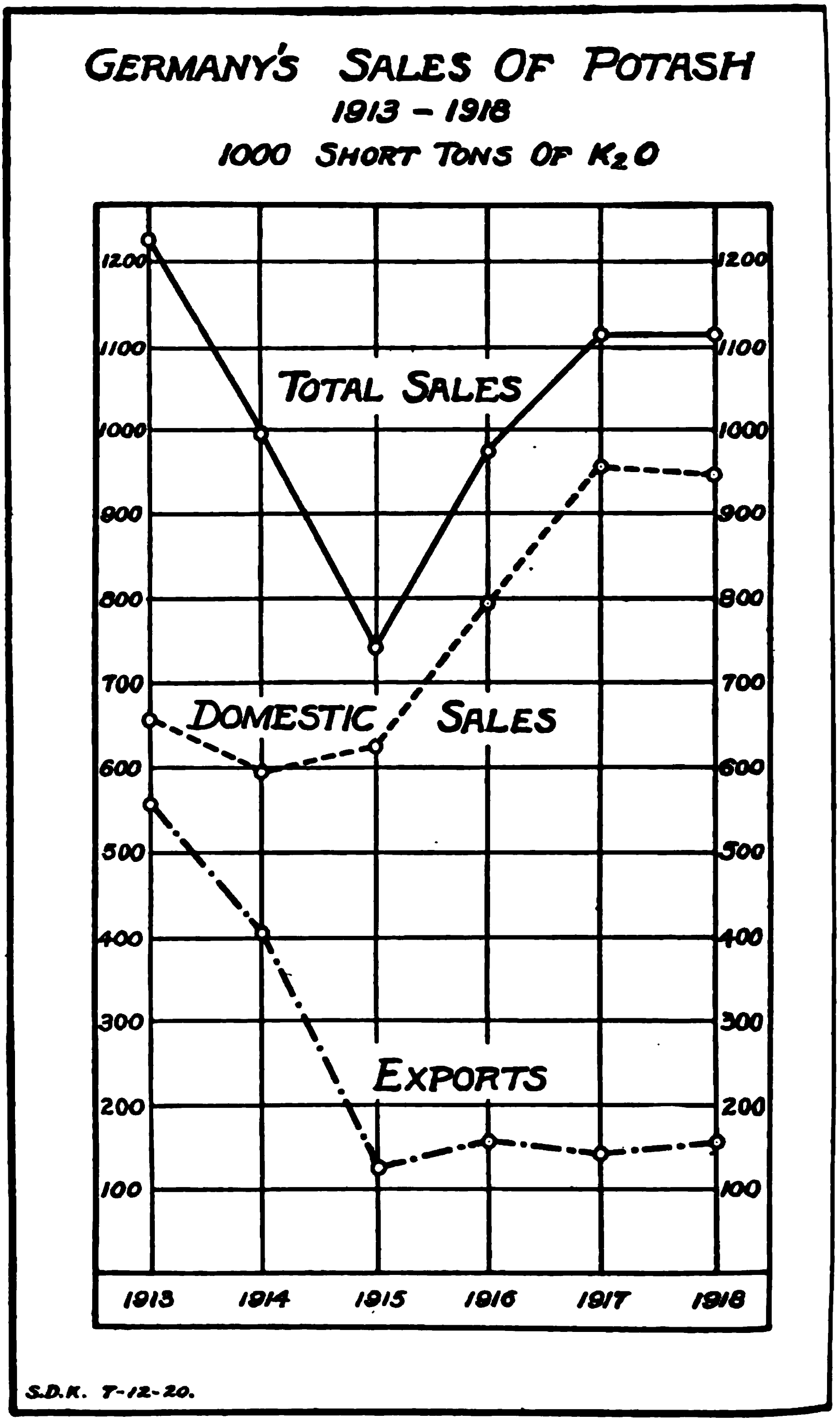
Production of potash in Germany.[1]

[In terms of actual potash [2] (K_2O) expressed in metric tons of 2,204 pounds.]

Year.	Metric tons.	Year.	Metric tons.
870	30,000	1914	904,137
880	68,550	1915	679,975
890	122,302	1916	883,696
900	303,610	1917	[3] 1,004,285
910	857,883	1918	[4] 1,001,171
911	939,927	1919	[5] 858,439
913	1,110,274		

[1] The Potash Supply with Special Reference to the United States, a pamphlet published by the German otash Syndicate, Berlin, p. 32, 1913. The Potash Industry, a pamphlet published by the German Kali Vorks (Inc.), New York, pp. 35, 39, 40, 1916.
[2] The actual weight of crude salts mined is about ten times the figures here given, since the crude salt verages about 10 per cent of actual potash.
[3] Sales according to Frankfurter Zeitung July 10, 1918, published in Commerce Reports, Oct. 9, 1918.
[4] The German Potash Industry, British Board of Trade Journal, Mar. 18, 1920.
[5] Oil, Paint, and Drug Reporter, Feb. 23, 1920, p. 55.

More than one-half of the total production is consumed in Germany ınd a little less than one-quarter in the United States. The normal ›rewar consumption of the United States may be taken as approx-mately 270,000 short tons of actual potash per year.


GERMANY'S SALES OF POTASH
1913 - 1918
1000 SHORT TONS OF K_2O
1200
1100
1000
900
800
700
600
500
400
300
200
100
TOTAL SALES
DOMESTIC SALES
EXPORTS
1913
1914
1915
1916
1917
1918
S.D.K. 7-12-20.

Actual potash (K_2O) content of potash salts imported for consumption in the United States, 1905–1918.

[From Mineral Resources of the United States, 1918.]

Year.	Short tons.	Year.	Short tons.
1905	129,084	1912	253,678
1906	155,974	1913	270,720
1907	144,351	1914	207,089
1908	136,057	1915	48,867
1909	173,220	1916	7,885
1910	279,780	1917	8,100
1911	274,446	1918	7,957

The potash in these German deposits exists in the form of the minerals, sylvinite (potassium chloride or muriate), carnallite (double chloride of potassium and magnesium), kainite (double sulphate of potassium and magnesium), associated with common salt, anhydrite (calcium sulphate), and kieserite (magnesium sulphate), some bromides and borates, and many other minerals of minor importance. A German geologist has estimated that the supply is sufficient to provide for a consumption of 5,000,000 tons per year for 600,000 years.

The salts are mined by methods similar to the methods of mining coal, and the costs, therefore, probably approximate the cost of coal mining. Much of it, especially the kainite, is put on the market for fertilizer without other treatment than grinding and bagging. Imports of kainite into the United States averaged about 500,000 tons per year.

Carnallite is present in the deposits in abundance and is the material from which the muriate is made by a simple and cheap process involving primarily crystallization from water.

The industry is controlled by a syndicate in which the Prussian Government is a partner. The syndicate has been supported by the German Government to the extent of compelling all mines to join it. The price of potash salts has been maintained much above a competitive price, but low enough to keep an almost complete monopoly of the world's markets.[1]

[1] See Tosdal, H. R.: The Kartell movement in the German potash industry, Quarterly Journal of Economics, vol. 28, pp. 140–190; also Report on Fertilizer Industry, pp. 104–119, published by Federal Trade Commission, 1916.

Total quantities of crude salts extracted from mines of the German Potash Syndicate.

1890	838,526	6,951	401,870	31,916	1,[illegible]
1895	782,944	3,012	669,531	76,097	1,[illegible]
1900	1,697,803	2,047	1,189,394	147,791	3,[illegible]
1901	1,860,189	2,335	1,432,136	190,034	3,[illegible]
1902	1,705,664	1,821	1,354,528	188,820	3,[illegible]
1903	1,[illegible]	1,553	1,582,867	196,140	3,[illegible]
1904	1,[illegible]	1,055	1,906,823	234,455	4,[illegible]
1905	2,[illegible]	2,730	2,405,536	230,621	4,[illegible]
1906	2,[illegible]	9,190	2,754,021	284,943	5,[illegible]
1907	2,[illegible]	10,359	2,788,973	304,143	5,[illegible]
1908	2,[illegible]	18,473	2,921,712	306,282	6,[illegible]
1909	3,[illegible]	7,387	3,268,290	344,749	6,901,[illegible]
1910	[illegible]82,885		4,577,893		8,[illegible]
1911	[illegible]41,664		5,264,843		9,[illegible]
1912	[illegible]81,642		5,7[illegible]8,371		11,[illegible]
1913	[illegible]02,350		6,305,160		11,[illegible]

[1] Federal Trade Commission report on the fertilizer industry.

Deposits similar to the Stassfurt mines were discovered in 1904 in Upper Alsace near Mulhouse. The total reserves of these deposits, which consist almost entirely of the chlorides of sodium and potassium, have been estimated at one and one-half billion tons of crude salt, roughly equivalent to 300,000,000 tons of potash (K_2O).[2] The exploitation of the mines began in 1910, and in August, 1914, 14 of the 18 mines were controlled by the German Kali Syndicate. Inland transportation facilities either by rail or barge are ample and when the military authorities turn the mines over to private control and necessary capital is provided to bring the production to a more efficient basis, the Alsatian deposits will offer severest competition to the German syndicate. The German monopolistic control over prices is definitely broken and the American consumer will benefit thereby.

The Alsatian production during 1919 was 591,471 tons, an increase of almost 70 per cent over the production in 1913, which amounted to 350,341 tons. The production in 1919 was equivalent to 96,546 tons of pure potash. Of this amount 30 per cent was exported to the United States.

The Stassfurt and Alsatian deposits were, at the outbreak of the European war, the only known deposits which were soluble in water and present in solid form. They are readily available for use as fertilizer and for industrial purposes. These deposits gave the control of the world's potash trade to Germany.

SIGNIFICANCE OF POTASH IN AGRICULTURE AND IN CHEMICAL INDUSTRIES.

Compounds of potassium or potash, as it is commercially called, occur in great abundance and widely scattered areas. F. W. Clarke, of the United States Geological Survey, estimates that 3 per cent

[2] Binder, Felix: L'Industrie de la Potasse de la Haute-Alsace, Dec. 24, 1917.

f the outer 10 miles of the earth consists of the element potassium. All but a small fraction of this enormous amount of potash occurs in he mineral feldspar and other silicate rocks. The ocean contains oluble potash salts in enormous aggregate amounts, but in such ilute solution that very little has been recovered commercially from his source.

Potash in the form of feldspar and other silicate rocks is insoluble nd not directly available for agricultural or chemical uses. Feldspar s a complex silicate of potassium, sodium, and aluminum, in which he potash is held in such firm chemical combination that large mounts of energy are necessary to decompose it. Any process of lecomposing feldspar is, therefore, necessarily more expensive than he utilization of the readily soluble potash salts from the German leposits. Many attempts have been made to recover potash from eldspar, but none have successfully competed with potash from ther sources. There is no hope that such a process of decomposing eldspar can be successful in competition with the other sources of potash unless the aluminum and silica are recovered in salable form (as Portland cement, or as pure oxide of aluminum or metallic aluminum) and of a value sufficient to offset the high cost of the process which makes the potash in a sense a by-product.

Potash is present in all tillable soils and is essential to the growth of all plants. In the form of feldspar, it is insoluble and not directly available to plants. Feldspar in soil, however, decomposes, even though slowly, gradually making the potash available. The process requires centuries for completion, and thus maintains the fertility over long periods. The productiveness of some soils is limited by the available or soluble potash content. On such soils the addition of potash salts, which are soluble and therefore readily available to plants, may increase the value of the crop by an amount greater than the cost of the added potash salts. The question of whether the use of fertilizer containing potash is an economic advantage depends on the nature of the soil, the crop to be grown, the cost of the potash, and the price received for the crop. Potash is especially needed on muck soils; its addition to the black loam of the middle western prairies is, however, unnecessary and of doubtful economic advantage, especially for grain crops. The crops which show the greatest need of potash are cotton, potatoes, tobacco, and citrus fruits. In the United States the cotton crop needs and has in the past taken by a substantial margin more potash than any other crop. Some soils in the cotton-growing section yield good crops without the addition of potash, but a large proportion of the cotton-growing area is greatly benefited by its use. The lack of potash in the soil can not be compensated for by the addition of other fertilizers. Phosphates, nitrates, and lime, or other fertilizer material serve a distinct and

largely independent function in the growth of the plant. The greatest market for potash in the United States has been in the South Atlantic States.

Germany has consumed more potash than all the rest of the world combined. The German Potash Syndicate has been active in stimulating the sale of potash throughout the world by means of advertisements, demonstration farms, and exhibits. The following statistics of the consumption of actual potash (K_2O) in agriculture not including industry, in the most important consuming countries, are taken from German official sources. The quantity is given in short tons.

World's consumption of potash in agriculture, by countries, 1910–1917.[1]

							1916	1917
	Tons.	*Tons.*	*Tons.*	*Tons.*	[illegible]	*Tons.*	*Tons.*	*Tons.*
Germany	395,269	464,575	509,722	589,713	[illegible]0	572,232	748,617	[illegible]
Belgium	9,886	10,011	12,040	14,501	[illegible]8	11,742	11,670	[illegible]
Holland	32,338	37,812	43,421	47,826	[illegible]8	31,972	62,535	[illegible]
France	25,134	29,115	34,860	36,426	[illegible]7	65	1	
United Kingdom	20,084	22,992	25,756	25,572	[illegible]2	.....	.....	
Luxemburg	118	193	312	442	1	1,632	1,800	[illegible]
Austria	12,996	16,572	20,767	23,072	[illegible]4	18,61[illegible]	27,820	[illegible]
Hungary	1,477	3,019	4,110	4,508	[illegible]0	2,835	3,514	[illegible]
Switzerland	3,055	2,945	3,851	3,639	[illegible]8	2,785	7,556	[illegible]
Italy	6,161	6,667	8,025	6,990	[illegible]0	521	.....	
Russia	16,003	18,787	25,762	24,920	[illegible]3	1,424	3,972	[illegible]
Spain	8,083	10,830	9,910	9,122	[illegible]2	252	.....	
Portugal	870	1,214	1,218	1,365	[illegible]5	60	.....	
Sweden	18,290	19,197	22,737	21,465	26,671	24,909	24,968	[illegible]
Norway	1,937	2,511	3,774	3,953	5,271	3,967	4,379	[illegible]
Denmark	4,804	6,195	6,607	8,222	8,212	8,553	18,260	[illegible]
Finland	1,080	1,459	1,565	1,766	684	.....	.....	
Balkan States	152	414	408	218	806	200	53	.....
Asia	3,531	5,137	6,406	6,281	4,633	707	36	[illegible]
Africa	1,808	2,523	3,455	4,807	2,126	121	.....	
United States	139,063	206,141	233,446	254,859	167,749	5,551	.....	
Canada			307	1,513	337	.....	.....	
Remainder of North and South America	8,345	7,467	8,614	10,140	7,271	.....	.....	
Australia	1,996	1,970	2,883	2,739	1,187	.....	.....	

[1] This table and the one which follows it are taken from an article on the German potash industry during the war, published Nov. 1, 1919, in the Fortnightly Information Review of the American Chamber of Commerce in France. The figures for 1918 are from an official publication of the German Foreign Office.

The following statistics, from the same sources, show the percentage of German potash used in agriculture and in the industries, in short tons of actual K_2O:

German potash used in agriculture and in industry, 1910–1918.

Year.	Domestic sales.	Foreign sales.	Total.	Value calculated on legal prices.	Value at par.	Used in agriculture.	Used in industry.
	Tons.	*Tons.*	*Tons.*	*Marks.*		*Per cent.*	*Per cent.*
1910	460,618	346,473	807,091	133,800,000	$31,800,000	88.3	[illegible]
1911	527,822	441,941	969,763	160,100,000	38,100,000	90.5	[illegible]
1912	581,422	524,514	1,105,936	186,400,000	44,400,000	89.5	[illegible]
1913	664,711	556,695	1,221,406	202,500,000	48,200,000	90.4	[illegible]
1914	591,590	402,797	994,387	164,500,000	39,200,000	91.2	[illegible]
1915	623,807	123,947	747,754	111,700,000	26,600,000	92.0	[illegible]
1916	797,548	174,825	972,373	163,900,000	39,000,000	[illegible]	[illegible]
1917	958,625	146,084	1,104,709	230,500,000	54,900,000	95.7	[illegible]
1918	945,688	156,143	1,191,831	300,000,000	71,400,000	95.7	[illegible]

Potash salts are also used for many industrial purposes, but before he war these uses consumed only about one-tenth of the total. For ll of these industrial purposes (but not for fertilizer) the potash salt ompetes with the corresponding soda salt. The potash salt will nly be used if it has a special advantage which justifies the payment f a higher price. Since the outbreak of the European war the differnce in price between the potash and soda salts has increased. This as caused a marked substitution of soda salts for potash salts in nany cases.

Although most glass is soda glass, potash (as carbonate) is used or certain varieties of glass, especially cut-glass tableware (flint glass), lectric-light bulbs, and certain varieties of optical glass. Potash ends to give the glass a lower melting point and to make it more efractive than does soda.

The consumption of soda in making soap far exceeds the consumption of potash, but potash (as hydroxide) is used in some varieties of soap, especially wool-scouring soaps.

There are a number of other salts of potash which are preferred for use in the chemical industries to the corresponding soda salts, because the potash salt is more readily crystallized or shows less tendency to become moist by absorption of water from the air. This is true of the permanganate, chlorate, and perchlorate, bromide, iodide, chromate and bichromate, ferrocyanide and nitrate. (See p. 172ff, for discussion of the uses of the salts.) The relative advantage of the potash salt over the soda salt varies greatly in different cases, and therefore the difference in price which consumers are willing to pay varies according to the use the soda or potash salt is to serve. At one time cyanide was usually marketed as the potash salt, but the soda salt had practically driven potassium cyanide out of the market even before the outbreak of the war.

DEVELOPMENT OF THE INDUSTRY IN THE UNITED STATES FROM BEGINNING OF THE WAR TO SIGNING OF THE ARMISTICE.

At the outbreak of the war the United States, in common with the rest of the world, was practically dependent on Germany. Imports into the United States for the fiscal year ending June 30, 1914, had been the greatest on record, a total of 1,085,004 tons, valued at $16,350,019. During the second half of 1914 imports continued, although in greatly reduced volume. At the end of 1915, Germany put an embargo on the further exportation of potash salts. This was followed by a rapid advance in the price. The grade of muriate of potash commonly used for fertilizer (80 to 85 per cent pure), which had sold in New York at $39.07 on July 1, 1914, rose to $230 on July 1, 1915, and to $475 on January 1, 1916. Crude carbonate

Geological Survey: "Potash in 1916," by Hoyt S. Gale, "Potash in 1917," by Hoyt S. Gale and W. B. Hicks, and "Potash in 1918," by W. B. Hicks.

The increase in domestic production of potash and the growth of the industry during the period 1915–1919 is shown in the following table:

Potash produced and sold in the United States, 1915–1919.

Year.	Number of producers.		Production.		Sales.[1]		
	Total.	Exclusive of producers of wood-ash potash.	Crude potash.	Available content of potash (K_2O).	Crude potash.	Available content of potash (K_2O).	Value f. o. b. plant.
			Short tons.	*Short tons.*	*Short tons.*	*Short tons.*	
1915[2]	5	5	4,374	1,090	4,374	1,090	$342,880
1916	70	25	35,739	9,720	35,739	9,720	4,242,720
1917	96	46	126,961	32,573	126,961	32,573	13,980,577
1918	128	77	207,686	54,503	140,343	38,880	15,839,618
1919[3]	77	45	119,736	33,418	----------	----------	----------

[1] Production and sales were practically the same from 1915 to 1917, and no distinction was made between them.

[2] Although no production was reported from wood ashes, it is probable that an appreciable quantity of potash was produced from that source in 1915.

[3] Supplied by the United States Potash Producers' Association.

DETAILED PRODUCTION BY YEARS.

1916.—The manufacturers of potash salts and potash products in e United States reported a production in 1916 of 35,739 short tons, ving a mean content of about 27 per cent of potash (K_2O), and a tal content of 9,720 short tons of potash (K_2O). This is almost actly ten times the production reported for 1915.

Potash produced in the United States in 1916, classified according to source.

Source.	Available potash (K_2O).	
	Quantity (short tons).	Value at point of shipment.
tural salts or brines	3,994	$1,987,600
mite and silicate rocks, including recoveries through furnace dust	1,850	715,000
lp	1,556	781,100
od ashes (potash pearlash)	[1] 412	270,000
tillery waste (molasses)	1,845	500,900
cellaneous organic sources	63	38,130
Total	9,720	4,242,730

The reported production from wood ashes amounted to 825 tons of salts of varying grades, containing ut 50 per cent of potash.

1917.—The output of all potash materials produced and marketed the United States in 1917, as reported by the manufacturers to e United States Geological Survey, was 126,961 short tons, which ntained 32,573 short tons, or an average of 26 per cent, of pure tash (K_2O). This is more than three times the quantity produced 1916.

Potash produced in the United States in 1917, classified according to source.

Source.	Number of producers.	Total production.	Available potash (K_2O).	Value at point of shipment.
		Short tons.	*Short tons.*	
neral resources:				
Natural brines	10	79,876	20,652	$3,261,873
Alunite (refined salts and crude and roasted alunite)	3	7,153	2,402	892,763
Dust from cement mills	8	13,582	1,621	700,523
Dust from blast furnaces	3	2,133	185	68,841
ganic sources:				
Kelp	10	11,306	3,572	2,114,815
Molasses residue from distilleries	4	8,589	2,846	1,130,907
Wood ashes	49	1,035	621	549,150
Evaporated Steffens water from sugar refineries	5	[1] 2,642	369	147,830
Evaporated wool washings and miscellaneous industrial wastes	3	645	305	113,875
Total	95	126,961	32,573	13,980,577

[1] Includes 1,333 tons of material produced but not sold in 1917.

1918.—In 1918 the manufacturers reported a production of potash aterials amounting to 207,686 short tons, containing 54,803 short ns, or an average of 26.5 per cent of pure potash (K_2O). This is an crease of 68.5 per cent over the 1917 production of crude potash aterials.

Potash produced and sold in the United States in 1918, classified according to source

Source.	Number of producers.	Production.			Sales.		
		Crude potash (short tons).	Available content of potash (K_2O).		Crude potash (short tons).	Available content of potash (short tons).	Value f. o. b. plant
			Quantity (short tons).	Percentage of total.			
Mineral:							
Natural brines—							
Nebraska lakes	19	116,662	28,854	53	57,522	14,011	$5,09[illegible]
Other sources	8	32,390	10,862	20	30,849	10,319	4,14[illegible]
Alunite	4	6,180	2,621	5	6,180	2,621	1,2[illegible]
Dust from cement mills	12	12,652	1,549	3	11,172	1,366	33[illegible]
Dust from blast furnaces	6	3,155	310	.5	3,155	310	152,5[illegible]
Silicate rocks							
Organic:							
Kelp	8	14,029	4,804	9	14,029	4,804	2,29[illegible]
Molasses, distillery waste	8	11,792	3,467	6	11,792	3,467	1,33[illegible]
Steffens water from beet-sugar refineries	8	8,795	1,374	2	3,650	742	26[illegible]
Wood ashes	51	1,100	673	1	1,063	651	34[illegible]
Wool washings and miscellaneous	4	931	289	.5	931	289	13[illegible]
	128	207,686	54,803	100	140,343	38,580	15,539,[illegible]

1919.—Statistics of the United States Potash Producers' Association for 1919 show an output of 119,736 short tons of crude potash materials, representing a total of 32,418 short tons of actual potash (K_2O).[1] The average potash content was 27 per cent. This production is about equal to that for 1917 and a decrease of about 40 per cent from the production of 1918. This decrease, according to the association, was caused by a decreased demand in anticipation of heavy importations from Europe.

Potash produced in the United States in 1919, classified according to source.

Source.	Number of producers.	Crude potash.	Available content of potash.	
			Quantity.	Percentage of total.
		Short tons.	*Short tons.*	
Natural brines:				
Nebraska lakes	10	34,142	8,586	2[illegible]
Other brines	6	49,313	13,722	4[illegible]
Molasses, distillery waste	5	8,407	2,854	[illegible]
Steffens waste water	6	9,371	3,295	1[illegible]
Alunite, silicates, kelp	4	4,179	2,057	[illegible]
Cement mill dust	11	12,285	1,236	3[illegible]
Wood ashes	32	932	583	1[illegible]
Blast furnace dust	3	1,107	85	[illegible]
Total	77	119,736	32,418	10[illegible]

[1] Official production statistics for 1919 have not been published by U. S. Geological Survey. (August 1, 1920.)

although the term bittern is not strictly applicable to a solution that contains no salts of magnesia. It is undoubtedly the liquor that remained after the crystal salts were formed by the natural concentration of the waters from the ancient lake that occupied this basin.

Analysis of salts in brine of Searles Lake, Calif.

Potassium chloride (KCl)	4.02
Borax ($Na_2B_4O_7$)	1.05
Sodium carbonate (Na_2CO_3)	4.27
Sodium sulphate (Na_2SO_4)	6.43
Sodium chloride (NaCl)	17.15
Total	32.92
Total determined	33.30

Probably no satisfactory means has been devised to determine the proportion of brine to crystalline salts in the deposit, but it is undoubtedly large. The salt crust itself is a porous mass, through which the brine flows so readily that the proportion of pore space, and consequently of brine, must be considerable. The original estimate of the Geological Survey that this pore space constitutes at least one-fourth of the volume of the deposit seems to be moderate. Continued pumping has shown only slight changes in the brine level, which quickly readjusts itself.

This deposit contains relatively more borax than the Nebraska deposit. It is being developed by two companies, but the production has been delayed by legal and technical complications. The production during 1916 was, therefore, small, but there can be little doubt that the output will eventually surpass the Nebraska lake district. The companies plan to separate the salts by a suitable refining process and to sell refined potassium chloride with other salts as by-products, especially borax, soda, sodium sulphate, and sodium chloride.

The Salduro, Utah, brine contains sodium, potassium, and magnesium chlorides, but very little sulphate and no carbonate or borate. This deposit resembles the German deposits more closely than any found in the United States. One great drawback in the operation of this plant is that all the water needed must be brought to the plant in tank cars. No production was secured during 1916, but the plant may become one of the largest producers in the country.

There are also three companies extracting potash from the water of the Great Salt Lake, which resembles ocean water in the proportion of the dissolved salts, but which is nearly six times as concentrated. A small output has also been secured from ocean water as a by-product of salt making. All of these plants are at a great distance from the South Atlantic States, the largest market for potash salts. None of them furnish a raw material as concentrated or as pure as the German potash deposits, and many of them are hampered by lack of water. The total amount of potash available in all of these saline deposits now known is probably only a fraction of 1 per cent of the amounts available in Germany.

During 1917, 79,876 short tons of crude potash salts containing 20,652 short tons of actual potash were produced from natural brines by 10 establishments. During 1918, there were 27 producers and the output was 148,952 short tons, containing 39,716 short tons of actual potash. In 1919 the number of producers fell off to 16 and their output was but 83,455 short tons of crude salts containing 22,308 short tons of actual potash.

ALUNITE.

Alunite is a mineral which is essentially a double potassium aluminum sulphate, which is insoluble in water. It is first heated to a red heat which decomposes the alunite and makes the potash soluble and the aluminum insoluble. The roasted mineral is leached with water and potassium sulphate recovered by evaporation. Commercial production has come almost entirely from mines near Marysvale, Utah. This deposit is not advantageously located, being about 6 miles from the nearest railroad and in a section of the country remote from any market. That potash can be produced from this source at a cost to compete with the German potash seems improbable unless processes can be devised which recover the aluminum oxide also in marketable form.

DUST FROM CEMENT MILLS.

Probably the most promising of all the attempts to recover potash is as a by-product of Portland cement mills. The flue dust from Portland cement mills has long been an annoyance. The first mill to install an effective device to collect the dust was the Riverside Portland Cement Co., of Riverside, Calif. The cement dust settled on oranges in its vicinity and made them unsalable. The owners of the orange groves brought damage suits against the Riverside Portland Cement Co. which compelled it either to abate the nuisance or close the mill.

A Cottrell electrostatic dust precipitator was installed which proved to be highly efficient. The dust collected was found to be rich enough in soluble potash salts to be valuable and salable as a fertilizer. Later the quality of the product was improved by leaching the dust with water and recovering a high-grade potash salt by crystallization. A nuisance was thus converted into a profitable by-product. It was then found that the yield of potash could be increased by adding a small proportion (up to 3 per cent) of feldspar to the cement raw material. . t has also been found that the addition of a small amount of salt increases the liberation of potash from the cement. Fortunately the operative conditions most favorable for potash recovery are also most favorable for the production of cement of the best quality. The Security Cement & Lime Co., of Hagerstown, Md., was

the second company to install the Cottrell dust-collection system, and also secured a marked success, both technically and financially. This plant started operations toward the end of 1916. By the close of 1917 six additional plants were in operation, and by the end of 1918 the process was in operation at 12 cement mills. In 1918 the output was 12,652 tons of crude dust containing 1,549 tons of actual potash.

The permanency of this branch of the new potash industry seems reasonably assured. The operating costs are low. It seems improbable that potash prices will go so low in the future that the value of the product will fall below operating expenses.

The demonstrated technical success of the process is likely to result in legal pressure on all cement mills to compel the installation of the necessary equipment to abate the dust nuisance to the surrounding country. Under these circumstances the potash will be collected and sold for whatever it will bring, regardless of whether the returns are greater or less than the operating cost. It has been estimated by the Department of Agriculture that if this equipment were installed at all of the cement mills in the United States, the yield would be 75,000 tons of actual potash (K_2O), or nearly one-third of the normal prewar consumption.

DUST FROM BLAST FURNACES.

There is a possibility that potash may be secured as a by-product in the pig-iron blast furnace. The raw materials fed into the blast furnace contain a minute percentage of potash, but the aggregate amount is large. Under the usual process, 80 per cent of this potash is volatilized in the furnace and passes out with the gases from the top of the furnace. The gases are then washed with water to remove most of the dust and are then burned in hot blast stoves or under boilers. Most of the potash is irretrievably lost in these wash waters, which are too dilute to permit the profitable recovery of the potash. However, a part escapes the washers and gradually accumulates in the stoves and boilers from which it must be cleaned out periodically. This dust contains sufficient potash to make it salable as fertilizer. During 1917 three companies only were selling this dust. The amount of actual potash (K_2O) contained in the dust sold was only 185 tons.

Experiments to develop a dry method of collecting the dust have been made with considerable promise of success. A systematic study of iron ores and fluxes has been made by the Department of Agriculture, and actual experiments have been made by the Bethlehem Steel Co. and United States Steel Corporation. This work indicates that there is not sufficient potash in the Lake Superior iron ores to make its recovery profitable, but that the southern ores, Cuban ores, and ferromanganese ores contain sufficient potash to make its commercial recovery a promising prospect.

KELP.

A great deal of attention has been given to the production of potash from kelp. The output of the nine companies which reported production during 1916 was 1,556 tons of actual potash (K_2O). During 1917 there were 10 companies in operation with an output of 11,306 short tons of crude material containing 3,572 tons of actual potash (K_2O). During 1918 the number of producers dropped to eight, but the output increased to 14,029 tons of crude salts containing 4,804 tons of actual potash. Kelp is a giant seaweed that grows along the Pacific coast of the United States. It has an exceptional power to absorb potash from sea water. The air-dried kelp contains from 10 to 15 per cent of actual potash, chiefly in the form of the muriate, together with a little more than 1 per cent of ammonia and a little less than 1 per cent of phosphoric acid, both of which have fertilizer value.

An estimate prepared by F. K. Cameron, of the Department of Agriculture, in 1915, was to the effect that the annual growth of kelp contains more than five times the prewar consumption of potash in the United States. Recent experience of the industry, however, indicates that these estimates are many times too great and that much of the kelp can not be commercially harvested.

When the industry first started there was no control over the harvesting of the kelp, but anyone was free to cut the kelp when and where he pleased. As the industry developed this plan resulted in difficulties. There proved to be insufficient amounts conveniently accessible to the factories, and the consequent rivalry resulted in excessive and premature cutting.

The California Legislature passed a bill putting control of the kelp beds in the hands of the California Fish and Game Commission and imposing a tax on the kelp harvested. During the winter of 1916–17 a portion of the beds was seriously damaged by a disease.

The purely technical problems of harvesting the kelp have been solved by the invention of a submarine harvester mounted on a sea-going barge, which cuts the kelp about 6 feet under the surface and loads it into the barge. The cost is said to be about $1 per ton of wet kelp.

There are three distinct methods of marketing the product. The simplest method is to dry the kelp and then grind it to a powder, which may be sold as fertilizer. This method utilizes the ammonia and phosphoric acid for fertilizers also; it has the great drawback, however, that over 80 per cent of the dried product is valueless and the cost of shipment, therefore, probably will prevent its distribution except in local markets.

The second method is to heat the dried kelp to a low red heat, thereby charring it and driving off much of the useless organic matter.

The product is a "kelp char" containing about 30 per cent of potash. In the future, arrangements will probably be made to collect volatile by-products, but little has been accomplished along these lines yet. The "kelp char" may be sold for fertilizers as such or it may be leached with water to extract the potash salts. A high-grade potash salt may be recovered by crystallization. The process is used in several plants operated by private firms and also in a plant built and operated by the Department of Agriculture. It is planned to carry out extensive experimental work in this Government plant for the purpose of developing the best methods of treatment and for the recovery of all possible by-products. The most important of these by-products probably will be iodine, a high-priced material not produced in the United States.

A third process is to decompose the wet kelp by fermentation. By this method the vegetable matter is largely converted into acetic acid with small amounts of butyric and propionic acids. This process has been adopted primarily to secure the acetic acid, for which there was a great demand in the manufacture of explosives. After fermentation, the liquid is filtered and the salts are separated by evaporation and crystallization. The potash salts are really a by-product rather than the main product of this reaction. The potash is marketed in the form of a high-grade muriate of about 97 per cent purity. Other by-products include iodine, ethyl butyrate, and ethyl propionate. The process was devised and the plant built by the Hercules Powder Co. as a result of an offer by the British Government of a contract for the explosive cordite at a high price, but with the provision that the acetone needed to make the explosive should not be obtained from any known source, but should be obtained by a new plant and new process. This plant was shut down soon after the signing of the armistice.

It is not probable that potash can be commercially recovered from kelp when normal conditions are restored, except, perhaps, for purposes of local use. In fact, several of the plants shut down within a few months after the signing of the armistice before any German or Alsatian potash reached the American markets.

MOLASSES DISTILLERY AND BEET-SUGAR WASTES.

Potash has been obtained as a by-product from distilleries utilizing molasses as a raw material. The potash is contained in the juice of the sugar cane and is concentrated in the molasses when the sugar is crystallized. The molasses is then fermented and the alcohol produced distilled. The potash remains in the residue in the still. In the past the residue has usually been discarded. The high prices which have recently prevailed have made it possible to recover the potash profitably by evaporation and crystallization. It is not

be expected that this operation will be continued when normal prices again prevail. During 1918 eight firms produced 3,467 short-tons of actual potash from this source.

Molasses contains about 4 per cent of potash. The Geological Survey estimated that if all the potash were recovered from the molasses fermented and distilled in the United States about 30,000 tons of potash would be obtained.

A small production has been secured as a by-product of the beet-sugar industry, the potash being recovered from waste liquor from which the sugar has been removed as completely as possible. In 1918, eight firms produced 8,795 tons of crude material containing 1,374 tons of actual potash (K_2O).

It is estimated that the sugar beets grown annually in the United States contain 18,000 tons of potash. It is obvious that potash as a by-product of the sugar industry offers no hope of a real solution of potash shortage. Even if the recovery of the potash were complete, all of it would have to go back to the fields from which it was taken in order to maintain their fertility, and no surplus would be left for other crops.

WOOD ASHES.

Wood ashes at one time furnished the only commercial source of potash salts, and this source has been revived on a small scale. The potash obtained from this source is a by-product of lumber mills or woodworking establishments using hardwoods. The sawdust and scrap is usually burned as fuel. The ashes are rich in potash. The wood ashes may be used directly as fertilizer or a more concentrated salt may be made by mixing with lime and leaching with water, followed by evaporation. The product is a mixed carbonate and hydroxide which is used for chemical purposes. There were 49 plants which produced potash from these sources in 1917, the output of which was 1,035 tons of crude material, containing 621 tons of actual potash. In 1918, 51 firms produced 1,100 tons of crude potash, containing 673 tons of actual potash. The output per plant is small. The industry is centered around the hardwood lumber districts of Michigan and Wisconsin. There is no prospect that the output will become large enough to be comparable with the normal consumption of potash. A small output of 92 tons of actual potash was secured by three firms from other industrial wastes, chiefly wool scourings.

DEVELOPMENT IN OTHER COUNTRIES.

Probably the most important new development in other countries has been the discovery that some of the Chilean sodium nitrate deposits contain appreciable amounts of potassium nitrate. Methods

suitable for the separation of the sodium and potassium nitrates have been devised and put into operation both in Chile and in the United States.

A process for the separation of the sodium and potassium nitrates has been put into operation by the Du Pont Co. and has reached an output of over 1,000 tons of actual potash per year in the form of the nitrate. If this process was used by all nitrate plants it is estimated that over 100,000 tons of potash would be recovered.

Japan has also become an exporter of potash, especially the muriate and chlorate. Although little definite information in regard to the Japanese industry is available, it is believed that kelp is the primary source of most of the potash.

There have been various reports of the discovery of deposits of potash salts resembling the German deposits in Spain and Abyssinia and of alunite deposits in Italy and Australia, but there has been very little commercial development from these sources. A beginning has been made in the recovery of potash from cement mills and blast furnaces in England, Canada, Spain, and Japan.

INDIVIDUAL SALTS AND POTASH MATERIALS.

POTASSIUM CARBONATE AND BICARBONATE.

Uses.—The carbonate is used in the manufacture of soft soaps, of Bohemian and flint glass, in dyeing, and in wool washing. The bicarbonate is used in the preparation of the pure carbonate.

Manufacture.—Potassium carbonate was formerly obtained almost entirely from wood ashes, but now very little is produced from this means, except in Russia and to a small extent in the United States.

Much is now manufactured from the Stassfurt salts by the Leblanc process. By this process the potash salts are mixed with powdered coal and limestone and heated in a furnace which converts them to carbonate. This carbonate is purified by solution and evaporation.

Potassium carbonate is also recovered to some extent from the distillery waste of molasses obtained from beet-sugar manufacture.

Domestic production.—During 1918, 229,287 pounds of refined potassium carbonate and bicarbonate were produced. Of this, 201,574 pounds were marketed for $104,432. In addition, 1,827,000 pounds of crude carbonate from wood ashes were produced and 1,753,000 pounds, valued at $331,000, were sold.

Imports.—Prior to the war, imports of carbonate of potash, including crude or black salts, were about 20,000,000 pounds per year and came chiefly from Germany. The import decreased during the war to a minimum of about 2,000,000 pounds in 1916. In 1918 the imports had increased to over 14,000,000 pounds and over 90 per cent of this quantity came from Russia.

Imports for consumption.

POTASH, BICARBONATE OF.

Fiscal year.	Rate of duty.	Quantity.	Value.	Duty collected.	Value per unit of quantity.	Actual and computed ad valorem rate.
		Pounds.				*Per cent.*
1909	25 per cent	342,856	$16,915	$4,228	$0.049	25.00
1910	do	334,300	16,633	4,158	.049	25.00
1911	do	325,016	16,428	4,107	.051	25.00
1912	do	275,204	13,155	3,288	.048	25.00
1913	do	311,645	14,295	3,573	.046	25.00
1914	do	96,991	4,474	1,118	.046	25.00
1914	½ cent per pound	381,862	18,293	1,909	.048	10.44
1915	do	383,534	20,341	1,917	.053	9.43
1916	do	2,062	614	10	.298	1.66
1917	do	10,053	5,271	50	.524	.95
1918	do	171,528	84,381	857	.492	1.01
1919	do	87,946	25,119	440	.285	1.75

POTASH, CRUDE OR BLACK SALTS.

1909	Free	9,628,966	$324,540		$0.033	
1910	do	8,407,373	263,643		.031	
1914	do	2,599,883	52,454		.020	
1915	do	4,076,783	83,502		.020	
1916	do	1,540,149	53,752		.035	
1917	do	2,819,235	233,111		.083	
1918	do	727,588	112,235		.154	
1919	do	268,441	12,814		.047	

POTASH, CARBONATE OF, CRUDE.

1911	Free	10,680,341	$327,400		$0.031	
1912	do	6,747,150	211,602		.031	
1913	do	10,063,912	295,066		.029	
1914	do	9,046,302	240,451		.027	
1915	do	8,620,504	291,341		.034	
1916	do	444,241	27,689		.062	
1917	do	1,069,408	185,910		.174	
1918	do	13,183,741	2,928,289		.222	
1919	do	1,092,792	373,745		.342	

POTASH, CARBONATE OF, REFINED.

1909	Free	11,009,479	$379,392		$0.034	
1910	do	9,036,267	303,917		.034	
1911	do	11,143,144	396,728		.036	
1912	do	11,627,209	383,958		.033	
1913	do	14,035,111	412,587		.029	
1914	do	10,421,005	368,958		.035	
1915	do	2,377,940	92,959		.039	
1916	do	174,587	38,604		.221	
1917	do	202,385	53,170		.262	
1918	do	445,282	124,019		.278	
1919	do	130,040	40,980		.315	

Imports by countries.

POTASH, CARBONATE OF, INCLUDING CRUDE OR BLACK SALTS.

[Free.]

Imported from—	1909		1910		1911	
	Pounds.	Value.	Pounds.	Value.	Pounds.	Value.
Germany	12,819,188	$462,370	11,186,415	$384,230	15,908,275	$534.
France	2,320,931	66,063	2,384,244	63,666	3,468,812	86.
Belgium	3,279,776	84,878	2,259,339	60,530	1,800,112	45.
Netherlands	.....	.....	32,704	1,076	53,672	1.
All other	2,218,528	90,621	1,570,700	57,923	1,569,481	53.
Total	20,638,423	703,932	17,433,402	567,445	22,800,352	724,

Imported from—	1912		1913		1914	
	Pounds.	Value.	Pounds.	Value.	Pounds.	Value.
Germany	13,139,550	$442,580	16,092,080	$515,567	12,876,305	$419.
France	1,332,118	38,734	1,102,786	28,545	1,415,966	30.
Belgium	1,781,030	46,608	2,252,247	56,598	2,517,034	54.
Netherlands	11,427	232	.....	.....	.....	.....
All other	1,611,682	51,295	2,792,336	83,035	3,794,288	109.
Total	17,875,807	579,449	22,239,449	683,745	20,603,593	614,

Imported from—	1915		1916		1917	
	Pounds.	Value.	Pounds.	Value.	Pounds.	Value.
Germany	8,788,653	$295,719	2,305	$121	.....	.....
France	85,502	2,949	358,400	3,281	.....	.....
Belgium	259,948	6,351	.....	.....	.....	.....
Netherlands	58,692	3,028	584,512	17,535	1,247,140	$76.
All other	3,841,976	113,232	1,173,070	98,812	3,252,400	395.
Total	13,034,771	421,279	2,118,287	119,779	4,499,540	472,

Imported from—	1918 [1]		1919	
	Pounds.	Value.	Pounds.	Value.
Germany	.....	.....	.....	.....
France	.....	.....	.....	.....
Belgium	.....	.....	.....	.....
Netherlands	.....	.....	.....	.....
All other	.....	.....	.....	.....
Total	14,468,211	$3,166,043	1,491,273	$427,

[1] Over 10,000,000 pounds of the total was imported from Russia.

POTASSIUM CHLORATE.

Description and uses.—Potassium chlorate is a white crystalline substance which is not very soluble in cold water. It is a strong oxidizer and when mixed with sulphur and charcoal forms an explosive powder.

It is used where an oxidizer is required, as in the manufacture of atches, fireworks, percussion caps and certain explosive powders. is also used as an oxidizer in dyeing aniline black. The purified ılorate is used in medicine.

Manufacture.—An electrolytic process is generally used in the ıanufacture of potassium chlorate. A solution of potassium chloride subjected to the action of a direct electric current in an electrolytic ell so that the chlorine and caustic potash which are formed come ı contact with each other and combine to form potassium hypo-ılorite. The reaction is carried out at a temperature sufficiently igh to cause the decomposition of the hypochlorite into potassium hlorate. The solution of potassium chlorate is withdrawn from the pparatus and the potassium chlorate is crystallized from the solution.

Domestic production.—In 1914 the production of potassium and odium chlorates combined was 8,304 short tons, valued at $1,131,316. During 1918, 4,877 short tons of potassium chlorate valued at 2,837,892 were produced by the three manufacturers.

Imports.—The imports of potassium chlorate have been rather poradic. The largest importation prior to the war was in 1913, when ver 1,200,000 pounds were imported. The imports during the war ıave been considerably less than this quantity, until in 1918 when the mport was about 1,000,000 pounds. Japan has been very active n the production of potassium chlorate during the war and it is likely hat this import originated in Japan.

Imports for consumption.

POTASH, CHLORATE OF.

Fiscal year.	Rate of duty.	Quantity.	Value.	Duty collected.	Value per unit of quantity.	Actual and computed ad valorem rate.
		Pounds.				*Per cent.*
1909	2½ cents per pound	20,801	$1,655	$520	$0.079	31.42
1910	2 cents per pound	413,885	26,608	8,277	.064	31.11
1911	do	25,069	2,096	501	.083	23.92
1912	do	42,131	3,444	842	.082	24.47
1913	do	1,235,732	66,609	24,714	.054	37.10
1914	do	7,380	704	147	.095	20.97
1914	½ cent per pound	32,939	2,704	164	.082	6.09
1915	do	27,419	4,614	137	.168	2.97
1917	do	437,339	194,008	2,186	.444	1.13
1918	do	1,006,320	357,520	5,031	.355	1.41
1919	do	315,565	113,498	1,578	.359	1.39

Exports.—Exports of potassium chlorate are not shown in Commerce and Navigation prior to 1918 when there was exported 1,564,662 pounds valued at $681,128. Australia and British Africa were the chief consuming countries.

POTASSIUM CHLORIDE (MURIATE OF POTASH).

Description and uses.—Potassium chloride, known commercially as muriate of potash, occurs as the mineral sylvite, and also in carnallite, a mixed chloride of potassium and magnesium, in the Stassfurt and other salt deposits of Europe. When pure it is a white crystalline solid readily soluble in water.

The chief use of the crude salt is as a fertilizer. It is also used as the crude material for the preparation of caustic potash and chlorate of potash by the electrolytic process.

Manufacture.—Germany manufactures large quantities of potassium chloride from the Stassfurt carnallite. The method of manufacture depends upon the fact that carnallite is decomposed by water which separates crystals of potassium chloride and causes the magnesium chloride to pass into solution. On heating, much more potassium chloride passes into solution, which, on cooling, separates almost entirely free from magnesium chloride. In actual practice the carnallite is dissolved in hot water until saturated, when it is filtered from any insoluble matter and then allowed to cool. On cooling, nearly pure potassium chloride separates, provided the proportion of magnesium chloride in solution does not exceed three times the potassium chloride. The liquor may be used for dissolving fresh portions of carnallite. The potassium chloride may be purified by washing with cold water or by dissolving and recrystallizing.

Some potassium chloride is also obtained from kelp and some from the liquors left from the manufacture of salt from sea water.

Domestic production.—Potassium chloride has been produced in this country during the war. In 1918 the production of muriate of potash was 31,486 tons of crude salt, containing 13,184 tons of actual potash (K_2O). In addition there was produced 6,589 tons of a low grade chloride of potash, containing 901 tons of actual potash (K_2O).

Imports.—Prior to 1916 the United States imported most of the potassium chloride it consumed from Germany, the amount in 1914 being 237,886 tons, with a value of $7,915,523. Since then the total imports have fallen off greatly, the records showing only 606 tons in 1917, mostly from Scotland and Japan, and 723 tons in 1918. There have been no imports from Germany since 1916, when only 3 tons were imported from that country.

Imports by countries.

POTASH, MURIATE OF.

[Free.]

Imported from—	1909		1910		1911	
	Tons.	Value.	Tons.	Value.	Tons.	Value.
Germany	131,802	$4,724,505	174,589	$5,635,011	190,354	$6,343,719
Netherlands	607	22,527	.....	.....	.....	.....
Belgium	123	4,220	.....	.....	1,464	71,479
All others	202	7,645	145	5,630	689	34,378
Total	132,734	4,758,897	174,734	5,640,641	192,507	6,449,576

Imported from—	1912		1913		1914	
	Tons.	Value.	Tons.	Value.	Tons.	Value.
Germany	215,627	$7,225,779	201,200	$6,781,181	236,218	$7,854,895
Netherlands	255	7,568	.....	.....	434	12,858
Belgium	75	2,371	20	865	94	3,529
All others	.....	.....	.....	10	1,140	44,241
Total	215,957	7,235,718	201,220	6,782,056	237,886	7,915,523

Imported from—	1915		1916		1917	
	Tons.	Value.	Tons.	Value.	Tons.	Value.
Germany	90,443	$3,112,559	8	$800	.....	.....
Netherlands	10,163	434,282	.....	.....	.....	.....
Belgium	.....	.....	.....	.....	.....	.....
All others	2,126	119,277	2,122	460,631	.....	.....
Total	102,732	3,666,118	2,130	461,431	606	$174,806

Imported from—	1918		1919	
	Tons.	Value.	Tons.	Value.
Germany	.....	.....	.....	.....
Netherlands	.....	.....	.....	.....
Belgium	.....	.....	.....	.....
All others	.....	.....	.....	.....
Total	723	$195,154	1,677	$201,307

Imports for consumption.

POTASH, MURIATE OF.

Fiscal year.	Rate of duty.	Quantity.	Value.	Value per unit of quantity.
		Tons.		
1909	Free	132,740	$4,758,906	$35.85
1910	do	174,935	5,640,541	32.24
1911	do	191,324	6,449,575	33.71
1912	do	216,101	7,235,728	33.48
1913	do	199,854	6,737,757	33.71
1914	do	234,855	7,925,781	33.75
1915	do	102,882	3,660,353	35.58
1916	do	2,126	460,888	216.78
1917	do	606	174,806	288.45
1918	do	596	156,979	263.38
1919	do	1,677	201,307	120.04

POTASSIUM CHROMATE AND DICHROMATE.

Description.—These are both salts of potash and chromic acid and have much the same uses. Both crystallize well, but the dichromate being much less soluble in cold water crystallizes better and is the one usually prepared. The chromate may be converted to the dichromate by treatment with acids and the dichromate to the chromate by treatment with an alkali. Potassium chromate is yellow and potassium dichromate is orange red.

Uses.—Potassium dichromate is used to a much greater extent than the chromate of potash, owing to its greater richness in chromic acid and the fact that it is more easily crystallized and purified. It is a strong oxidizing agent. The chief uses of dichromate of potash are in the chrome tanning of leather, textile dyeing and printing, manufacture of chrome pigments and colors, pickling of brass, and the electroengraving of copper plates. It is also used in bleaching oils and fats, for other oxidation purposes, and as a chemical reagent. Wherever possible the cheaper sodium salt is now being used instead of the potassium salt.

Manufacture.—Potassium chromate and bichromate are prepared from chrome iron ore or chromite, the larger portion of which is imported. The ore is pulverized and mixed with lime and potassium carbonate. This mixture is then heated to bright redness in a strong current of air. The fused mass is then lixiviated with water forming a solution of calcium and potassium chromates. Additional potash, usually potassium sulphate, is added to the solution to convert the calcium chromate into potassium chromate. The clear solution of potassium chromate is then drawn off and treated with sulphuric acid, thus producing potassium dichromate which is crystallized from the solution.

Domestic production.—During 1918 there were four producers of potassium chromate and bichromate and their output was reported to be 681,346 pounds. Sales during that year were reported to be 1,003,598 pounds valued at $407,793.

Imports.—The imports since 1910, have not been more than 40,000 pounds and have been entirely negligible since 1915.

Imports for consumption.

POTASH, CHROMATE AND DICHROMATE OF.

Fiscal year.	Rate of duty.	Quantity.	Value.	Duty collected.	Value per unit of quantity.	Actual and computed ad valorem rate.
		Pounds.				Per cent.
1910	3 cents per pound	171,541	$12,[illegible]	$5,146.00	$0.[illegible]	[illegible]
1911	2½ cents per pound	[illegible]	[illegible]	19,735.00	.[illegible]	[illegible]
1912	do	[illegible]	[illegible]	514.00	.[illegible]	[illegible]
1913	do	[illegible]	[illegible]	562.00	.[illegible]	[illegible]
1914	do	[illegible]	[illegible]	625.00	.[illegible]	[illegible]
1915	1 cent per pound	34[illegible]	[illegible]	345.00	.[illegible]	[illegible]
1916	do	[illegible]	[illegible]	462.00	.[illegible]	[illegible]
1917	do	[illegible]	[illegible]	22.00	.[illegible]	[illegible]
1918	do	[illegible]	[illegible]	34.00	.[illegible]	[illegible]
1919	do	[illegible]	[illegible]	.20	.[illegible]	[illegible]
1920	do					

Imports by countries.

POTASH, CYANIDE OF.[1]

[Dutiable.]

Imported from—	1912		1913		1914	
	Pounds.	Value.	Pounds.	Value.	Pounds.	Value.
Germany	2,291,719	$343,749	777,441	$117,101	167,830	$
England	284,979	41,973	231,454	29,495	49,616	
Belgium	145,432	21,210	.....	.....	.....	.....
All other	35,049	3,846	.....	.....	.....	.....
Total	2,757,179	410,778	1,008,895	146,596	217,446	

[Free.]

Imported from—	1914		1915		1916	
	Pounds.	Value.	Pounds.	Value.	Pounds.	Value.
Germany	460,042	$59,360	179,972	$28,710	25	$
England	130,561	20,470	55,924	9,519	10,050	
Austria-Hungary	.....	.....	709,797	104,575	.....	.....
All other	672	126	830,024	20,924	33,600	
Total	591,275	79,956	1,775,717	163,728	43,705	

Imported from—	1917		1918		1919[2]	
	Pounds.	Value.	Pounds.	Value.	Pounds.	Value.
Germany	.....	.....	.....	.....	.....	.....
England	.....	.....	10,988	$2,212	.....	.....
Austria-Hungary	.....	.....	.....	.....	.....	.....
Spain	.....	.....	130,770	45,173	.....	.....
Japan	72,772	$51,675	2,177	664	.....	.....
All other	31,807	24,533	290	274	.....	.....
Total	104,579	76,208	144,225	48,323	431,339	$

[1] 1909–1910 included in all other chemicals. 1911 included in all other salts of potash.
[2] Entirely from Canada.

POTASSIUM FERRICYANIDE (RED PRUSSIATE OF POTASH).

Description.—Potassium ferricyanide is known commercially as red prussiate of potash. It crystallizes from water in large red crystals without water of crystallization. It is poisonous and very soluble in water.

Uses.—Being a powerful oxidizer it is used in calico printing. Other uses are in the manufacture of blue-print paper and for the production of pigments, such as Turnbull's blue.

Manufacture.—The usual method of manufacture is to treat the ferrocyanide with chlorine. This is preferably done in solution.

Domestic production.—Figures for the domestic production are not available but it probably has increased considerably since 1915, as the imports have shown a very great decrease since then.

Imports.—In 1914 the imports were 89,976 pounds, nearly all of which came from Germany and Austria-Hungary. In 1915 the imports were only slightly less but in 1916 dropped to 2,040 pounds. Since then the imports have increased somewhat and in 1919 mounted to 13,992 pounds.

Imports for consumption.

POTASH, PRUSSIATE OF, RED.

Fiscal year.	Rate of duty.	Quantity.	Value.	Duty collected.	Value per unit of quantity.	Actual and computed ad valorem rate.
		Pounds.				*Per cent.*
1909	8 cents per pound	77,255	$13,522	$6,180	$0.175	45.71
1910	do	65,777	12,460	5,262	.189	42.23
1911	do	55,082	10,230	4,406	.186	43.07
1912	do	71,612	11,264	5,728	.158	50.86
1913	do	65,316	11,302	5,225	.173	46.23
1914	do	4,873	835	389	.172	46.69
1914	2 cents per pound	85,103	14,490	1,702	.170	11.75
1915	do	83,574	14,922	1,671	.178	11.20
1916	do	2,040	3,182	40	1.56	1.28
1917	do	4,523	10,425	90	2.30	.87
1918	do	9,924	18,495	198	1.86	1.07
1919	do	13,992	25,497	280	1.82	1.09

POTASSIUM FERROCYANIDE (YELLOW PRUSSIATE OF POTASH).

Description.—Potassium ferrocyanide, known as yellow prussiate of potash, crystallizes from water in large yellow crystals containing water of crystallization. When heated or exposed to dry air, the crystals lose their water and become a white powder. Potassium ferrocyanide is readily soluble in water and is not poisonous.

Uses.—Potassium ferrocyanide is used for the preparation of Prussian blue, in calico printing, for dyeing silk, for casehardening of iron, and for making potassium cyanide and ferricyanide. Small amounts are used in the manufacture of some explosives and as a reagent in analytical chemistry. Within the last few years sodium ferrocyanide has replaced potassium ferrocyanide for most purposes because it is much cheaper and in many cases is just as efficient.

Manufacture.—Formerly the method for manufacturing potassium ferrocyanide was to fuse nitrogenous organic matter with potassium carbonate and iron borings. The organic matter used was hides, hoofs, hair, blood, etc. After fusion, the remaining mass was treated with water near the boiling point for some hours, the solution drawn off, and the ferrocyanide allowed to crystallize.

At present potassium ferrocyanide is produced almost entirely from the spent oxide which is obtained during the purification of coal gas. This is first treated with water to dissolve out ammonia and soluble salts, then dried, the sulphur extracted with carbon bisulphide, and the residue mixed with lime. This is then heated

with steam and forms calcium ferrocyanide, and on treating this with potassium chloride a double calcium potassium ferrocyanide is formed. When this is treated with potassium carbonate, calcium carbonate separates and potassium ferrocyanide remains in solution.

Domestic production.—In 1909 the United States produced 3,510,[illegible] pounds of potassium ferrocyanide and in 1914, 3,204,684, which probably represented a little less than half of the total consumption. In 1918 there were but three producers and their output was 457,[illegible] pounds.

Imports.—The imports for 1914 amounted to 3,508,229 pounds, more than 50 per cent of which came from Germany and about 27 per cent from England. In 1915 the imports were 2,316,736 pounds but dropped the next year to 44,156 pounds. In 1918 the imports were 134,638 pounds.

Imports for consumption.

POTASH, PRUSSIATE OF, YELLOW.

Fiscal year.	Rate of duty.	Quantity.	Value.	Duty collected.	Value per unit of quantity.	Ad val. and commercial value rate
		Pounds.				*Per cent.*
1909	4 cents per pound	1,751,377	$178,744	$70,175	$0.102	[illegible]
1910	do	2,330,871	229,907	93,234	.097	[illegible]
1911	do	1,777,313	180,584	71,092	.101	[illegible]
1912	do	2,072,761	203,295	82,910	.098	[illegible]
1913	do	2,812,408	309,302	112,496	.110	[illegible]
1914	do	521,244	58,455	20,849	.112	[illegible]
1914	1½ cents per pound	2,986,984	331,566	37,337	.111	[illegible]
1915	do	2,316,736	255,711	28,959	.110	[illegible]
1916	do	44,156	31,651	551	.717	[illegible]
1917	do	41,128	32,251	514	.784	[illegible]
1918	do	134,638	111,096	1,683	.825	[illegible]
1919	do	58,003	45,869	725	.790	[illegible]

POTASSIUM HYDRATE.

Description.—This substance, also known as caustic potash or potassium hydroxide, is a white solid substance. It absorbs water and carbon dioxide readily from the air and is very easily soluble in water, giving a strongly caustic solution.

Uses.—It is used in the manufacture of soft soaps, in the preparation of oxalic acid, in the manufacture of some dyes, and in preparing caustic lyes, and as a chemical reagent. Owing to the great advance in price of potash salts it is being replaced wherever possible by sodium hydroxide.

Manufacture.—The usual method of manufacture is by the electrolysis of a solution of potassium chloride.

Domestic production.—There were 14 producers of potassium hydroxide during 1918 and their output was 1,984,847 pounds, of which 1,594,580 pounds were sold for $856,148.

Imports.—Since 1913 the imports have declined so that in 1917 the total imports amounted to only 68,095 pounds as compared to 8,896,805 pounds in 1913. Most of the imports before 1916 were from Germany.

Imports by countries.

POTASH, HYDRATE OF, OR CAUSTIC—NOT IN STICKS OR ROLLS.

[Free.]

Imported from—	1909		1910		1911	
	Pounds.	Value.	Pounds.	Value.	Pounds.	Value.
Germany	4,611,729	$204,720	6,183,411	$256,602	5,557,278	$244,936
Belgium	599,647	21,091	516,594	18,189	778,157	22,314
Austria-Hungary	499,012	18,966	608,677	23,184	341,214	12,044
United Kingdom	335,937	16,789	708,433	34,259	463,200	22,551
All others	986,334	33,143	776,276	25,699	284,297	8,152
Total	7,032,659	294,709	8,793,391	357,933	7,424,146	309,997

Imported from—	1912		1913		1914 [1]	
	Pounds.	Value.	Pounds.	Value.	Pounds.	Value.
Germany	7,024,946	$280,895	7,499,356	$289,351	1,682,631	$66,313
Belgium	541,480	17,499	416,232	15,169	5,726	190
Austria-Hungary	157,022	6,330	704,754	28,273	260,764	8,899
United Kingdom	343,502	16,049	123,278	6,238	33,605	2,083
All others	353,102	9,839	153,185	5,370	400	54
Total	8,420,052	330,612	8,896,805	344,401	1,983,126	77,539

POTASH, HYDRATE OF, CONTAINING NOT MORE THAN 15 PER CENT CAUSTIC SODA.

[Free.]

Imported from—	1914 [2]		1915		1916	
	Pounds.	Value.	Pounds.	Value.	Pounds.	Value.
Germany	5,867,065	$219,936	4,444,128	$179,599	4,500	$700
Belgium	63,706	2,246	47,938	1,485	.....	.....
Austria-Hungary	291,040	13,285	.....	.....	.....	.....
United Kingdom	48,173	3,005	52,272	5,918	.....	.....
All others	197,292	10,657	472,953	38,547	39,470	8,732
Total	6,467,276	249,129	5,017,291	225,549	43,970	9,432

Imported from—	1917		1918		1919	
	Pounds.	Value.	Pounds.	Value.	Pounds.	Value.
Germany	.....	.....	.....	.....	.....	.....
Belgium	.....	.....	.....	.....	.....	.....
Austria-Hungary	.....	.....	.....	.....	.....	.....
United Kingdom	11,355	$5,905	.....	.....	.....	.....
All others	[3] 56,740	24,508	.....	.....	.....	.....
Total	68,095	30,413	11,732	$4,398	466,620	$124,563

[1] Figures cover period July 1 to Oct. 3, 1913, inclusive.
[2] Figures cover period Oct. 4, 1913, to June 30, 1914.
[3] Chiefly from Sweden.

Imports for consumption.

POTASH, HYDRATE OF, OR CAUSTIC, NOT INCLUDING REFINED, IN STICKS OR ROLLS.

Fiscal year.	Rate of duty.	Quantity.	Value.	Duty collected.	Value per unit of quantity.	Actual and computed ad valorem rate.
		Pounds.				*Per cent.*
1909	Free	7,041,657	$294,709		$0.042	
1910	do	8,785,491	358,855		.041	
1911	do	7,426,402	309,965		.042	
1912	do	8,422,007	330,684		.039	
1913	do	8,994,449	348,500		.039	
1914	do	1,986,326	77,620		.039	

POTASH, HYDRATE OF, OR CAUSTIC, REFINED, IN STICKS OR ROLLS.

1909	1 cent per pound	127,611	$9,289	$1,276	$0.073	12.74
1910	do	141,430	11,094	1,414	.079	12.7
1911	do	82,854	9,254	828	.112	8.95
1912	do	77,184	8,096	771	.105	9.53
1913	do	112,821	11,919	1,128	.106	9.47
	D. R. U. S.	1	1			
1914	1 cent per pound	18,751	1,977	187	.105	9.46

POTASH, HYDRATE OF, NOT CONTAINING MORE THAN 15 PER CENT CAUSTIC SODA.

1914	Free	6,579,125	$249,030		$0.038	
1915	do	4,993,471	225,002		.045	
1916	do	39,770	9,222		.232	
1917	do	75,720	33,648		.450	
1918	do	11,732	4,398		.375	
1919	do	466,620	124,563		.0267	

POTASSIUM IODIDE AND IODATE.

Description and uses.—Potassium iodate is of very little commercial importance. Potassium iodide is an important medicinal and chemical reagent. Sodium iodide is replacing potassium salt to a great extent, because it is much cheaper and for most purposes it is equally suitable.

Domestic production.—During 1918 eight manufacturers reported a production of 521,678 pounds of potassium iodide. Sales during the year amounted to 481,301 pounds, valued at $1,587,656.

Imports.—The imports of potassium iodide and iodate were small and practically negligible prior to the war. Since 1916 the import has increased until in 1918 there was imported 65,992 pounds. Japan has exported considerable quantities of potassium iodide during the war, and it is likely that these imports were from that country.

Imports for consumption.

POTASH, HYDRIODATE, IODIDE, AND IODATE OF.

Fiscal year.	Rate of duty.	Quantity.	Value.	Duty collected.	Value per unit of quantity.	Actual and computed ad valorem rate.
		Pounds.				*Per cent.*
09	25 cents per pound	242	$489	$60	$2.02	12 35
10	do	142	275	35	1.93	12 91
11	do	272	519	68	1.91	13 10
12	do	238	451	59	1.89	13 19
13	do	120	239	30	1.99	12.55

POTASSIUM IODIDE.

14	15 cents per pound	162	$491	$24	$3.03	4.96
15	do	4	13	1	3.25	4.62
16	do	309	1,032	46	3 34	4 49
17	do	24,357	58,752	3,653	2 41	6.22
18	do	65,902	133,611	9,899	2 02	7.41
19	do	25,963	74,834	2,894	2.88	5.20

POTASSIUM NITRATE.

Description.—Potassium nitrate, or saltpeter, is the potassium salt f nitric acid. It is a white crystalline substance which is easily oluble in water.

Uses.—Potassium nitrate is one of the ingredients of ordinary unpowder and of some other explosives and fireworks. It is also sed in curing meats and as a reagent in assaying.

Manufacture.—Formerly potassium nitrate was obtained almost ntirely from niter earths, which occur mostly in India. Now much f it is produced by the double decomposition of sodium nitrate and otassium chloride. Before the war large quantities were made in nis way in Germany from the potassium chloride of Stassfurt and odium nitrate imported from Chile.

Domestic production.—There are no deposits of potassium nitrate the United States. In 1914 there was produced from imported aw materials 29,480,000 pounds of potassium nitrate, valued at 1,244,051. In 1918 production by four establishments amounted o 16,250,433 pounds, of which 8,176,382 pounds were sold for 2,206,788.

Imports.—The imports of crude nitrate in 1914 were 3,547,252 ounds, valued at $115,470. In 1915 the imports amounted to only 77,785 pounds, but increased greatly the next three years, amount-ng to 10,171,654 pounds in 1917 and 8,815,327 pounds in 1918. he largest imports on record were received during the fiscal year 919, amounting to 34,557,048 pounds, valued at $1,298,291.

Prior to 1914 most of the imports were from Germany and British ndia, but with the beginning of the war the German imports ceased

and those from India fell off greatly. In 1916 and 1917 the largest imports were from the United Kingdom, with South America ranking second.

Imports for consumption.

POTASH, NITRATE OF (OR SALTPETER), CRUDE.

Fiscal year.	Rate of duty.	Quantity.	Value.	Duty collected.	Value per unit of quantity.	Actual and computed ad valorem rate
		Pounds.				*Per cent*
1909	Free	17,470,648	$512,473		$0.029	
1910	do	11,848,195	349,199		.027	
1911	do	9,288,557	282,835		.03	
1912	do	6,172,441	213,258		.035	
1913	do	10,989,382	288,995		.026	
1914	do	3,547,252	115,470		.033	
1915	do	677,785	22,483		.033	
1916	do	5,412,130	734,123		.135	
1917	do	10,171,654	904,506		.089	
1918	do	8,815,327	956,853		.109	
1919	do	34,557,048	1,298,291		.037	

POTASH, NITRATE OF (OR SALTPETER), REFINED.

		Tons.				
1909	$11.20 per ton	185	$14,421	$2,076	$77.95	
1910	do	1,165	115,457	13,054	99.00	
1911	do	380	38,384	4,258	101.00	
1912	do	198	23,896	2,214	120.68	
1913	do	176	22,142	1,968	125.80	
1914	do	34	4,306	385	126.65	
1914	$7 per ton	128.5	15,867	899	123.48	
1915	do	54	4,222	238	78.18	
1916	do	2	749	14	374.50	
1917	do	288	35,143	2,016	122.00	
1918	do	43	16,193	301	376.60	
1919	do	1	96	7	96.00	

Imports by countries.

POTASH, NITRATE OF (OR SALTPETER), CRUDE.

Imported from—	1909		1910		1911	
	Pounds.	Value.	Pounds.	Value.	Pounds.	Value
Germany	510	$29	450,556	$7,741	132,710	$
British India	17,400,555	510,357	11,306,332	339,690	9,144,837	2
United Kingdom	66,231	2,007				
Canada	1,360	40				
All others	2,000	40	366	9		
Total	17,470,656	512,473	11,757,254	347,440	9,277,547	2

Imported from—	1912		1913		1914	
	Pounds.	Value.	Pounds.	Value.	Pounds.	Value
Germany	804,323	$13,593	4,964,700	$80,593	112,717	$
British India	6,171,431	213,258	6,166,352	207,358	3,433,863	113
United Kingdom			2,240	30		
Canada			23,178	1,014		
All others			[1] 57,456	1,497		
Total	6,975,754	226,851	11,213,926	290,492	3,546,580	115

[1] Chiefly Russia.

Imports by countries—Continued.

POTASH, NITRATE OF (OR SALTPETER) CRUDE—Continued.

Imported from—	1915		1916		1917	
	Pounds.	Value.	Pounds.	Value.	Pounds.	Value.
British India	670,930	$22,083	1,106,770	$152,705	456,000	$82,300
United Kingdom			4,282,960	577,055	5,102,643	736,594
Canada			120,415	27,695		
Chile					3,467,520	77,720
All others	[1] 6,855	400	[2] 22,400	4,363	1,145,491	7,892
Total	677,785	22,483	5,532,545	761,818	10,171,654	904,506

Imported from—	1918		1919	
	Pounds.	Value.	Pounds.	Value.
British India	257,600	$34,500	11,646,550	$857,413
United Kingdom	6,915,332	747,696		
Canada			336	66
Chile	32,080	1,432	22,719,197	426,060
All others	1,615,355	171,390	190,929	14,752
Total	8,820,367	955,018	34,557,048	1,298,291

[1] Cuba. [2] Japan.

POTASSIUM PERMANGANATE.

Description.—Potassium permanganate forms purplish black crystals with a greenish metallic luster. These dissolve in water, giving a deep purple red solution. It is a powerful oxidizer, and when mixed with organic matter may cause spontaneous combustion.

Uses.—It is used largely as an oxidizer. It is used for bleaching, in dyeing shoe leather and for coloring wood a deep brown, for purifying ammonia and carbon dioxide. It is used to some extent in medicine, especially as a local disinfectant and germicide. It is an important reagent in analytical chemistry. It is estimated that over 50 per cent of the domestic production of potassium permanganate during the war was used in the manufacture of saccharin.

Manufacture.—The usual method of manufacture is to mix a solution of potassium hydroxide with powdered manganese ore and potassium chlorate or potassium nitrate, evaporate to dryness, and fuse the residue until it becomes pasty. This forms potassium manganate, which is then dissolved in water and treated with sulphuric acid, chlorine, or carbon dioxide. On evaporation the permanganate crystallizes.

Another method which is used in this country is to fuse manganese ore with caustic soda, producing sodium manganate. This is oxidized electrolytically to sodium permanganate and caustic soda. This solution is then treated with carbon dioxide, forming soda ash,

which crystallizes on evaporation, leaving the sodium permanganat- in solution. The sodium permanganate is now treated with a potassium salt, preferably the carbonate, which produces the potassium permanganate. This is separated by crystallization. Sodium permanganate crystallizes very poorly.

Domestic production.—Prior to the war there was no production of permanganate of potash in this country. The shutting off of imports the demands for war purposes, and the large demand for the manufacture of saccharin have greatly stimulated the industry in the United States. Several firms manufactured permanganate of potash in this country during the war. In 1918 there were nine producers and their output was 562,416 pounds. Of this quantity 530,837 pounds were sold for $922,746.

Imports.—In 1914 the imports of potassium permanganate were 1,351,855 pounds, nearly all of which came from Germany, but by 1916 they had fallen to 208,979 pounds, and in 1917 to 5,695 pounds. In 1918 the imports were 43,826 pounds. Some was imported from Japan, but when the prices fell these imports were reduced, as Japan was not able to export to this country at the lower prices.

Imports for consumption.

POTASH, PERMANGANATE OF.

Fiscal year.	Rate of duty.	Quantity.	Value.	Duty collected.	Value per unit of quantity.	Actual and computed ad valorem rate.
		Pounds.				*Per cent.*
1909	25 per cent	592,805	$40,572	$10,143	$0.068	[illegible]
1910	do	565,215	38,479	9,619	.067	[illegible]
1911	do	638,159	44,135	11,033	.069	[illegible]
1912	do	432,937	29,932	7,483	.069	[illegible]
1913	do	357,366	25,314	6,328	.071	[illegible]
1914	do	75,260	5,269	1,317	.070	[illegible]
1914	1 cent per pound	1,276,595	85,796	12,765	.067	[illegible]
1915	do	1,039,304	78,924	10,393	.076	[illegible]
1916	do	208,979	56,146	2,089	.269	[illegible]
1917	do	5,695	9,391	50	1.84	[illegible]
1918	do	43,826	106,104	438	2.42	.4
1919	do	18,107	43,830	181	2.42	.4

POTASSIUM SULPHATE.

Description and uses.—Potassium sulphate in the pure state forms well-defined crystals which are soluble in water and have a bitter taste. It is used principally in the crude form as a fertilizer. It is also used for the production of potassium carbonate by the Leblanc process and in the manufacture of potash alum. Some is used by glass works.

Manufacture.—Large quantities of potassium sulphate are manufactured from kainite in Germany near Stassfurt. Kainite, which is a double sulphate of potassium and magnesium containing magnesium

chloride, is dissolved in water, and on concentrating this solution a mixed sulphate of potassium and magnesium separates. This, when treated with potassium chloride, forms potassium sulphate and magnesium chloride. The potassium sulphate, being the less soluble, crystallizes on evaporating the solution.

Potassium sulphate may also be made by treating potassium chloride with sulphuric acid. In this way hydrochloric acid is also produced.

Domestic production.—In 1918 the domestic production of sulphate of potash was 6,897 tons of crude salts containing 3,294 tons of actual potash (K_2O).

Imports.—Prior to the war all of that consumed in this country was imported from Germany, but there have been no imports from there since 1915. The total imports in 1914 were 45,139 tons, but had dropped to 661 tons in 1917, the greater part of which came from Japan. In 1918 only 135 tons were imported.

Imports for consumption.

POTASH, SULPHATE OF, CRUDE OR REFINED.

Fiscal year.	Rate of duty.	Quantity.	Value.	Value per unit of quantity.
		Tons.		
1909	Free	27,239	$1,148,607	$42.17
1910	do	37,933	1,399,915	36.90
1911	do	47,441	1,952,370	41.15
1912	do	45,134	1,853,235	41.05
1913	do	42,877	1,798,369	41.94
1914	do	7,596	315,029	41.47
1914	do	37,389	1,572,162	42.06
1915	do	21,705	1,071,623	49.37
1916	do	2,427	197,808	81.50
1917	do	656	20,538	31.30
1918	do	136	19,837	145.86
1919	do	137	23,304	170.10

Imports by countries.

POTASH, SULPHATE OF.

[Free.]

Imported from—	1909		1910		1911	
	Tons.	Value.	Tons.	Value.	Tons.	Value.
Germany	26,923	$1,132,396	37,987	$1,392,902	46,960	$1,927,504
Netherlands	.....	.....	88	4,082	100	3,076
United Kingdom	25	1,190	135	7,255	300	17,787
Belgium	206	10,309	.....	.....	31	1,710
All others	136	4,711	270	7,995	50	2,291
Total	27,290	1,148,606	38,480	1,412,234	47,441	1,952,368

Imports by countries—Continued.

POTASH, SULPHATE OF—Continued.

[Free.]

Imported from—	1912		1913		1914	
	Tons.	Value.	Tons.	Value.	Tons.	Value.
Germany	43,881	$1,802,731	42,696	$1,751,661	43,993	$1,827,763
Netherlands	508	18,630	.....	.....	221	11,[illegible]
United Kingdom	62	4,093	.....	.....	915	57,[illegible]
Belgium	25	1,382	49	1,824	10	[illegible]
All others	.....	.....	.....	.....	.....	.....
Total	44,476	1,826,836	42,745	1,753,485	45,139	1,897,740

Imported from—	1915		1916		1917	
	Tons.	Value.	Tons.	Value.	Tons.	Value.
Germany	18,973	$842,134	.....	.....	.....	.....
Netherlands	1,274	70,403	.....	.....	.....	.....
United Kingdom	54	3,126	.....	.....	.....	.....
Belgium	206	9,710	.....	.....	.....	.....
All others	1,345	146,388	2,423	$197,808	661	$20,[illegible]
Total	21,852	1,071,761	2,423	197,808	661	20,[illegible]

Imported from—	1918		1919	
	Tons.	Value.	Tons.	Value.
Germany	.....	.....	.....	.....
Netherlands	.....	.....	.....	.....
United Kingdom	.....	.....	.....	.....
Belgium	.....	.....	.....	.....
All others	.....	.....	.....	.....
Total	135	$19,837	137	$23,304

KELP.

Description.—The name kelp was originally applied to the ash obtained by burning seaweed. This was recovered for its soda and iodine content. The name has now been extended, especially in the United States, to apply to the weeds themselves, especially those which may be made to yield potash, iodine, and other valuable products.

Uses.—Kelp is used principally for the production of potash salts and iodine, though other valuable products may be obtained. Some of these are acetic acid, butyric acid, propionic acid, and acetone. It is reported that a process has been devised for obtaining alcohol in large quantities from kelp. Dried and ground kelp is sometimes used directly as a fertilizer.

Domestic production.—Very little kelp was utilized in this country before 1914, but the shortage of potash salts, due to the war in Europe, caused the utilization of large quantities of seaweed along the Pacific

coast. A number of plants started up for the manufacture of potash and other products from kelp and at least one of them had a capacity of close to 1,000 tons of fresh kelp per day.

Many of these plants have already shut down and the remainder probably will be compelled to if the price of potash goes down to anywhere near what it was before the war.

Imports.—Some kelp has been imported but the imports have been very small and irregular.

KAINITE.

Description.—Kainite is a natural product which occurs in the large salt deposits of Europe. It is a complex salt consisting of the sulphate of potash and the sulphate and chloride of magnesia and the water of crystallization. The commercial kainite contains at most only about 70 per cent of the mineral. When heated with water under pressure, it decomposes into a double sulphate of potassium and magnesium, potassium chloride, and magnesium chloride.

Uses.—Kainite is used in the crude state, without any treatment except grinding, as a fertilizer. Some of it is also used for the production of potassium sulphate.

Domestic production.—The United States produces no kainite, all that is used being imported.

Imports.—There have been no imports since 1916. All the kainite imported came from Germany. In 1914 the United States imported 41,846 tons. The imports have since decreased until in 1916 only 4 tons were imported.

Imports for consumption.

KAINITE.[1]

Fiscal year.	Rate of duty.	Quantity.	Value.	Value per unit of quantity.
		Tons.		
09	Free	344,525	$1,974,165	$5.73
10	....do	470,241	2,268,363	4.82
11	....do	586,474	2,637,105	4.49
12	....do	479,817	2,400,589	5.00
13	....do	466,184	2,149,689	4.61
14	....do	526,112	2,579,619	4.90
15	....do	79,124	444,996	5.62
16	....do	64	1,795	28.04
17	....do	.....	.....	.....
18	....do	.....	.....	.....

[1] Entered in 1909 as "Kieserite," kyanite, or cyanite, and kainite.

Manufacture.—It is produced by a partial purification of natural products and is essentially a mixture of potassium chloride, magnesium sulphate, and sodium chloride.

Manure salt is sold in two grades, the "single manure salt," sold on a basis of 20 per cent K_2O, and the "double manure salt," sold on a basis of 48 per cent K_2O.

Imports.—Imports of manure salts during the calendar year 1913 amounted to 223,687 tons,[a] valued at $2,245,509, but have fallen off rapidly since then, so that during the fiscal year 1918 the imports were only 225 tons, valued at $9,047.

Imports by countries.

MANURE SALTS.[c]

[Free.]

Imported from—	1911[b]		1912		1913	
	Tons.	Value.	Tons.	Value.	Tons.	Value.
Germany	738,947	$3,888,164	191,242	$1,788,783	168,843	$1,755,007
Netherlands	.....	.....	374	2,300	1,300	11,982
United Kingdom	1,308	10,824	.....	.....	11	811
All others	137	3,316	1,122	22,988	1,648	26,258
Total	740,392	3,902,304	192,738	1,814,071	171,802	1,794,058

Imported from—	1914		1915		1916	
	Tons.	Value.	Tons.	Value.	Tons.	Value.
Germany	256,703	$2,696,671	60,285	$650,749	.....	.....
Netherlands	2,247	19,805	2,442	40,636	.....	.....
United Kingdom	1,875	36,715	2,736	49,701	2,270	$41,785
All others	517	14,050	599	19,613	1	40
Total	261,342	2,767,241	66,062	760,699	2,271	41,825

Imported from—	1917		1918		1919	
	Tons.	Value.	Tons.	Value.	Tons.	Value.
Germany	.....	.....	.....	.....	.....	.....
Netherlands	.....	.....	.....	.....	.....	.....
United Kingdom	324	$7,794	190	$8,872	.....	.....
All others	.....	.....	.....	.....	.....	.....
Total	324	7,794	190	8,872	.....	.....

[c] Included in "All other fertilizers" in 1910. [b] "Manure salts and kainit."

[a] Figures from Mineral Resources, 1917.

Imports for consumption.

MANURE SALTS (INCLUDING DOUBLE MANURE SALTS).

[N. s. p. f.]

Fiscal year.	Rate of duty.	Quantity.	Value.	Value per unit of quantity.
		Tons.		
1910	Free	90,933	$928,357	$10.2
1911	....do	169,105	1,265,857	7.9
1912	....do	185,682	1,828,426	9.8
1913	....do	172,556	1,798,773	10.4
1914	....do	260,976	2,757,013	10.5
1915	....do	66,411	757,151	11.4
1916	....do	2,278	42,368	16.6
1917	....do	324	7,794	24.0
1918	....do	225	9,047	40.2

Imports by countries.

POTASH, ALL OTHER SALTS OF.[1]

[Dutiable.]

Imported from—	1911		1912		1913	
	Pounds.	Value.	Pounds.	Value.	Pounds.	Value.
Germany	4,271,328	$460,888	2,000,591	$188,250	2,464,585	$259.2
United Kingdom	772,139	67,345	762,353	50,252	1,967,180	121,8
France	45,386	4,182	311,018	27,857	411,158	42,0
Netherlands					110,588	10,5
All others	561,785	54,158	335,541	29,880	308,633	29,9
Total	5,650,638	586,573	3,409,503	296,239	5,282,144	463,8

Imported from—	1914		1915		1916	
	Pounds.	Value.	Pounds.	Value.	Pounds.	Value.
Germany	2,932,304	$258,464	2,765,858	$266,931	143,188	$11,4
England	1,924,311	179,532	465,531	42,310	120	1
France	435,671	48,300	11,533	1,260	11,246	17,7
Netherlands	167,649	19,001	584,909	55,195	441	4
All others	315,653	32,255	217,443	29,893	125,294	77,6
Total	5,775,588	537,592	4,045,274	395,589	280,289	106,8

Imported from—	1917		1918		1919	
	Pounds.	Value.	Pounds.	Value.	Pounds.	Value.
Germany					23,406	$1,5
England	662	$242	14,000	$4,452	2,800	1,1
France	4,408	5,510			11,023	3,1
Chile	560,000	18,751				
Japan	519,770	252,874	1,624,548	782,214	183,869	139,5
All others	11,738	11,598	23,605	16,961	24,690	1,7
Total	1,096,578	289,975	1,662,153	803,627	247,789	147,7

[1] Included in all other chemicals in 1909 and 1910.

Wholesale prices of potash.

[Data from Oil, Paint, and Drug Reporter.]

ALUM (POTASSIUM-ALUMINIUM SULPHATE).

[Per pound, New York, spot.]

an. 2, 1912	$0.01½–$0.02
pr. 1, 1912	.01½– .02
ly 1, 1912	.01½– .02
ept. 20, 1912	.01½– .02
ec. 30, 1912	.01½– .02
ar. 31, 1913	.01½– .02
une 30, 1913	.01½– .02
ept. 29, 1913	.01½– .02
ec. 29, 1913	.01½– .02
ar. 30, 1914	.01½– .02
une 29, 1914	.01½– .02
ept. 28, 1914	.02½– .03
ec. 28, 1914	.02½– .02¾
ar. 29, 1915	.02½– .02¾
une 28, 1915	.02½– .02¾
ept. 27, 1915	.03½– .05
an. 3, 1916	.04 – .05
pr. 3, 1916	.04¼– .04¾
ly 3, 1916	.04 – .04¼
ct. 2, 1916	.04 – .04¼
an. 1, 1917	.04 – .04¼
pr. 2, 1917	.04 – .04¼
ly 2, 1917	.04¼– .05
ct. 1, 1917	.04¼– .05
ec. 31, 1917	.06 – .06¾
pr. 1, 1918	.09 – .09¼
ly 1, 1918	.08 – .09
ctober, 1918	.11½– .12
anuary, 1919	.11 – .12
pril, 1919	.11 – .12
ly, 1919	.08 – .10
ctober, 1919	.08 – .10
anuary, 1920	.08 – .09
pril, 1920	.08 – .09

ACETATE OF POTASH.

[Per pound, New York, spot.]

une 28, 1915	.33 – .34
ept. 27, 1915	.40 – .42
an. 3, 1916	.50 – .51
pr. 3, 1916	1.45 – 1.46
ly 3, 1916	1.45 – 1.46
ct. 2, 1916	1.25 – 1.26
an. 1, 1917	1.25 – 1.26
pr. 2, 1917	1.25 – 1.26
ly 2, 1917	1.25 – 1.26
ct. 1, 1917	1.30 – 1.32
ec. 31, 1917	1.50
pril, 1918	1.50
ly, 1918	1.50
ctober, 1918	1.50
nuary, 1919	1.10 – 1.15
pril, 1919	.95 – 1.00
ly, 1919	.95 – 1.00
ctober, 1919	.70 – .75
nuary, 1920	.70 – .75
pril, 1920	.65 – .70

BICARBONATE OF POTASH.

[Per pound, New York, spot.]

ne 28, 1915	.30 – .32
pt. 27, 1915	.37 – .40
n. 3, 1916	.45 – .50
pr. 3, 1916	1.40
ly 3, 1916	1.65
ct. 2, 1916	1.25 – 1.35
n. 1, 1917	1.40 – 1.50
pr. 2, 1917	1.30 – 1.40
ly 2, 1917	1.30 – 1.40

BICARBONATE OF POTASH—Con.

Oct. 1, 1917	$1.25 –$1.30
Dec. 31, 1917	1.25 – 1.50
April, 1918	1.25 – 1.50
July, 1918	1.25 – 1.50
October, 1918	.70 – .75
January, 1919	.65 – .70
April, 1919	.65 – .70
July, 1919	.30 – .35
October, 1919	.31 – .34
January, 1920	.31 – .36
April, 1920	.33 – .43

BICHROMATE OF POTASH.

[Per pound, New York, spot.]

Jan. 1, 1912	.07– .07½
Apr. 1, 1912	.07– .07½
July 1, 1912	.07– .07½
Sept. 30, 1912	.06– .07
Dec. 30, 1912	.06– .07
Mar. 31, 1913	.06– .07
June 30, 1913	.06– .07
Sept. 29, 1913	.06– .07
Dec. 29, 1913	.06– .07
Mar. 28, 1914	.06– .07
June 29, 1914	.06– .07
Sept. 28, 1914	.15
Dec. 28, 1914	.12 – .13
Mar. 29, 1915	.15½– .16
June 28, 1915	.21
Sept. 27, 1915	.20 – .21
Jan. 3, 1916	.45
Apr. 4, 1916	.75
July 3, 1916	.42 – .45
Oct. 2, 1916	.38 – .50
Jan. 1, 1917	.42 – .43
July 2, 1917	.36 – .37
Oct. 1, 1917	.45 – .50
Dec. 31, 1917	.43½– .44
April, 1918	.43½– .45
July, 1918	.45 – .46
October, 1918	.42 – .45
January, 1919	.38 – .41
April, 1919	.35 – .38
July, 1919	.35 – .38
October, 1919	.26 – .28
January, 1920	.30 – .32
April, 1920	.38 – .40

CAUSTIC POTASH.

[Per pound, New York, spot.]

Jan. 2, 1912	.03½– .043
Apr. 1, 1912	.03½– .043
July 1, 1912	.03½– .043
Sept. 30, 1912	.03½– .043
Dec. 30, 1912	.03½– .043
Mar. 31, 1913	.03½– .043
June 30, 1913	.03 – .043
Sept. 29, 1913	.03 – .04½
Sept. 28, 1914	.17½– .20
Dec. 28, 1914	.07 – .08
Mar. 29, 1915	.22 – .25
June 28, 1915	.33 – .40
Dec. 31, 1917[1]	.63 – .64
Apr. 8, 1918[1]	.63½– .65
July 1, 1918[1]	.61 – .62
October, 1918[1]	.60 – .62
January, 1919[1]	.55 – .60
April, 1919[1]	.42 – .44
July, 1919	.28 – .30
October, 1919	.23 – .30
January, 1920	.23 – .25
April, 1920	.25 – .26

* When exact date is not specified, the quotation was taken on or about the first of the month.
[1] 70 to 75 per cent KOH.

Wholesale price of potash—Continued.

	Prices.
CAUSTIC POTASH (88 TO 92) PER CENT).	
[Per pound, New York, spot.]	
Sept. 27, 1915	$0.39 – $0.41
Jan. 3, 1916	.65 – .70
Apr. 3, 1916	.95 – 1.00
July 3, 1916	.83 – .90
Oct. 2, 1916	.85 – .90
Jan. 1, 1917	.90 – .95
Apr. 2, 1917	.88 – .90
July 2, 1917	.84 – .86
Oct. 1, 1917	.85 – .90
Dec. 31, 1917	.83 – .84
Apr. 8, 1918	.83½ – .85
July 1, 1918	.80 – .81
October, 1918	.70 – .72
January, 1919	.67 – .70
April, 1919	.50 – .52
July, 1919	.35 – .40
October, 1919	.28 – .35
January, 1920	.30 – .32
April, 1920	.31 – .35
CITRATE OF POTASH.	
[Per pound, New York, spot.]	
Sept. 28, 1914	.69 – .70
Dec. 28, 1914	.69 – .70
Mar. 29, 1915	.69 – .70
June 28, 1915	.69 – .70
Sept. 27, 1915	.73 – .75
Jan. 3, 1916 [2]	.73 – .75
Apr. 3, 1916 [3]	1.70 – 1.72
July 3, 1916 [3]	1.70 – 1.72
Oct. 2, 1916 [3]	1.50
Jan. 1, 1917 [3]	1.50
Apr. 2, 1917 [3]	1.54 – 1.56
July 2, 1917 [3]	1.54 – 1.56
Oct. 1, 1917 [3]	1.54 – 1.58
Dec. 31, 1917 [3]	1.60
April, 1918	1.60
July, 1918	1.60
October, 1918	1.70
January, 1919	1.78
April, 1919	2.02
July, 1919	1.84
October, 1919	1.84
January, 1920	1.78
April, 1920	1.78
CYANIDE OF POTASH, BULK.[4]	
[Per pound, New York, spot.]	
Jan. 1, 1912	.20 – .24
Apr. 1, 1912	.20 – .24
July 1, 1912	.20 – .24
Sept. 30, 1912	.19 – .24
Dec. 30, 1912	.19 – .24
Mar. 31, 1913	.19 – .24
June 30, 1913	.19 – .24
Sept. 29, 1913	.19 – .24
Dec. 29, 1913	.19 – .22
Mar. 28, 1914	.19 – .22
June 29, 1914	.19 – .22
Sept. 28, 1914	.22 – .23
Dec. 28, 1914	.25 – .26
Mar. 29, 1915	.18 – .25
June 28, 1915	.25 – .29
Sept. 27, 1915	.25 – .29
Jan. 3, 1916	Not listed.
Apr. 3, 1916	.37 – .38
July 3, 1916	.37 – .38
Oct. 2, 1916	1.00 – 1.20
Jan. 1, 1917 [4]	2.25 – 2.30

	Prices.
CYANIDE OF POTASH, BULK—Con.	
Apr. 2, 1917	$2.00 – $2.10
July 2, 1917	2.25 – 2.30
Oct. 1, 1917	2.25 – 2.30
Dec. 31, 1917	.60 – .70
April, 1918	.60 – .70
July, 1918	.60 – .70
October, 1918	.60 – .70
January, 1919	.60 – .70
CARBONATE OF POTASH, CALCINED (96 to 98 per cent).	
[Per pound, New York, spot.]	
Jan. 2, 1912	.0425– .045
Apr. 2, 1912	.0425– .045
July 1, 1912	.0425– .045
Sept. 30, 1912	.0425– .045
Dec. 30, 1912	.0425– .045
Mar. 28, 1913	.0422– .045
June 30, 1913	.0415– .045
Sept. 29, 1913	.0425– .045
Dec. 29, 1913	.0425– .045
Mar. 30, 1914	.04¼ – .04½
June 29, 1914	.04¼ – .04½
Sept. 28, 1914	.19
Dec. 28, 1914	.0725– .09
Mar. 29, 1915	.180 – .185
June 28, 1915	.22
Sept. 27, 1915	.28 – .30
Jan. 3, 1916	.45 – .50
Apr. 3, 1916	1.10
July 3, 1916	.95 – 1.00
Oct. 2, 1916	.60
Jan. 1, 1917	.50 – .60
Apr. 2, 1917 [5]	.70
July 2, 1917 [5]	.70
Oct. 1, 1917 [5]	.70
Dec. 31, 1917	.60 – .80
Apr. 1, 1918	.65 – .85
July 1, 1918	.65 – .75
October, 1918	.55 – .75
January, 1919	.40
April, 1919	.26 – .28
July, 1919	.21 – .22
October, 1919	Nominal.
January, 1920	.35 – .40
April, 1920	Nominal.
CARBONATE OF POTASH, CALCINED (80 TO 85 PER CENT).	
[Per pound, New York, spot.]	
Jan. 2, 1912	.03½– .04
Apr. 1, 1912	.03½– .04
July 1, 1912	.03½– .04
Sept. 30, 1912	.03½– .04
Dec. 30, 1912	.034– .034
Mar. 31, 1913	.034– .034
June 30, 1913	.034– .034
Sept. 29, 1913	.034– .034
Dec. 29, 1913	.03½– .034
Mar. 30, 1914	.031– .034
June 29, 1914	.03– .034
Sept. 28, 1914	.17
Dec. 28, 1914	.06 – .07
Mar. 29, 1915	.14 – .145
June 28, 1915	.20
Sept. 27, 1915	.23 – .24
Jan. 3, 1916	.45 – .50
Apr. 3, 1916	.90
July 3, 1916	.80 – .83
Oct. 2, 1916	.50
Jan. 1, 1917	.38 – .40

[2] Per cent not stated.
[3] 90 per cent.
[4] Not listed later than January, 1919.
[5] Bulk.
[6] Cyanide mixture.
[7] Nominal.

Wholesale price of potash—Continued.

	Prices.
CARBONATE OF POTASH, CALCINED (80 TO 85 PER CENT)—Contd.	
Apr. 2, 1917	$0.35 -$0.40
July 2, 1917	.45
Oct. 1 ,1917	.50
Dec. 31, 1917	.50 - .55
Apr. 1, 1918	.40 - .45
July 1, 1918	.38 - .40
October, 1918	.35 - .38
January, 1919	.30 - .32
April, 1919	.17 - .18
July, 1919	.12 - .14
October, 1919	.25
January, 1920	.24 - .26
April, 1920	.21 - .23
CHLORATE OF POTASH, CRYSTALS.	
[Per pound, New York, spot.]	
Jan. 2, 1912 [9]	.08½ - .09½
Apr. 1, 1912 [9]	.08½ - .09½
July 1, 1912 [9]	.08½ - .09½
Sept. 30, 1912 [9]	.08½ - .09½
Dec. 30, 1912	.08½ - .09½
Mar. 31, 1913	.08½ - .09½
June 30, 1913	.08½ - .09½
Sept. 29, 1913	.08½ - .09½
Dec. 29, 1913	.07½ - .07¾
Mar. 30, 1914	.07½ - .07¾
June 29, 1914	.07½ - .07¾
Dec. 28, 1914	.15
Mar. 29, 1915	.25 - .30
June 28, 1915	.30 - .30½
Sept. 27, 1915	.34 - .35
Jan. 3, 1916	.45 - .50
Apr. 3, 1916	.75
July 3, 1916	.53 - .70
Oct. 2, 1916	.48 - .70
Jan. 1, 1917	.65 - .70
Apr. 2, 1917	.60 - .70
July 2, 1917	.55 - .75
Oct. 1, 1917	.57½ - .60
Dec. 31, 1917	.40 - .41
Apr. 8, 1918	.41 - .42½
July 1, 1918	.39 - .41
October, 1918	.40 - .41
January, 1919	.39 - .41
April, 1919	.40
July, 1919	.25 - .30
October, 1919	.20
January, 1920	.15
April, 1920	.15
CARBONATE OF POTASH, HYDRATED (80 TO 85 PER CENT).	
[Per pound, New York, spot.]	
Jan. 1, 1912	.03½ - .04½
Apr. 1, 1912	.03½ - .04½
July 1, 1912	.03½ - .04½
Sept. 30, 1912	.03½ - .04½
Dec. 30, 1912	.03½ - .04½
Mar. 31, 1913	.03½ - .04½
June 30, 1913	.03½ - .04½
Sept. 29, 1913	.03½ - .04½
Dec. 29, 1913	.03½ - .04½
Mar. 28, 1914	.03½ - .04½
June 29, 1914	.03½ - .04½
Sept. 28, 1914	.22
Mar. 29, 1915	.16 - .17
June 28, 1915	.20
Sept. 27, 1915	.24 - .25
Jan. 3, 1916	.45 - .50
Apr. 3, 1916	1.15
July 3, 1916	.95 - 1.00
Oct. 2, 1916	.70
Jan. 1, 1917	.55 - .65

	Prices.
CARBONATE OF POTASH, HYDRATED (80 to 85 PER CENT—Continued.	
Dec. 31, 1917 [10]	$1.00 -$1.25
Apr. 8, 1918 [10]	1.00 - 1.25
July, 1918	Nominal.
October, 1918	.85 - .95
January, 1919	.85 - .95
April, 1919	.80 - .90
July, 1919	.55 - .65
October, 1919	.29 - .35
January, 1920	.33 - .35
April, 1920	.31 - .32
IODIDE OF POTASH, BULK.	
[Per pound, New York, spot.]	
Jan. 1, 1912	2.10 - 2.15
Apr. 1, 1912	2.10 - 2.15
July 1, 1912	2.40 - 2.45
Sept. 30, 1912	2.60 - 2.65
Dec. 30, 1912	2.60 - 2.65
Mar. 31, 1913	2.60 - 2.65
June 30, 1913	2.60 - 2.65
Sept. 29, 1913	2.95 - 3.00
Dec. 29, 1913	2.95 - 3.00
Mar. 28, 1914	2.95 - 3.00
June 29, 1914	2.95 - 3.00
Sept. 28, 1914	3.15 - 3.20
Dec. 28, 1914	3.15 - 3.20
Mar. 29, 1915	3.15 - 3.20
June 28, 1915	3.15 - 3.20
Sept. 27, 1915	3.70 - 3.75
Jan. 3, 1916	3.70 - 3.75
Apr. 3, 1916	4.30 - 4.35
July 3, 1916	3.90 - 3.95
Oct. 2, 1916	3.75 - 3.80
Jan. 1, 1917	3.45 - 3.50
Apr. 2, 1917	2.90 - 2.95
July 2, 1917	2.90 - 2.95
Oct. 1, 1917	2.90 - 2.95
Dec. 31, 1917 [11]	3.75 - 3.80
April, 1918 [11]	3.75 - 3.80
July, 1918 [11]	3.75 - 3.80
October, 1918	3.75 - 3.80
January, 1919	3.50 - 3.55
April, 1919	3.50 - 3.55
July, 1919	3.30 - 3.35
October, 1919	3.55 - 3.60
January, 1920	3.35 - 3.40
April, 1920	3.10 - 3.15
MURIATE OF POTASH (80 TO 85 PER CENT; BASIS, 80 PER CENT).	
[Per ton, New York, spot.]	
Jan. 2, 1912	38.05
Apr. 1, 1912	38.05
July 1, 1912	38.55
Sept. 30, 1912	38.55
Dec. 30, 1912	38.55
Mar. 31, 1913	38.55
June 30, 1913	38.55
Sept. 29, 1913	38.65
Dec. 29, 1913	38.65
Mar. 30, 1914	39.07
June 29, 1914	39.07
Sept. 28, 1914	39.57
Dec. 2, 1914	39.57
Mar. 29, 1915	160.00
June 28, 1915	230.00- 250.00
Sept. 27, 1915	245.00- 250.00
Jan. 3, 1916	475.00- 500.00
Apr. 3, 1916	415.00- 420.00
July 3, 1916	290.00- 350.00
Oct. 2, 1916	400.00- 420.00
Jan. 1, 1917	450.00- 460.00

[9] F. o. b. works.
[10] Carbonate, hydrated.
[11] Listed "Iodine, potassium."

Wholesale prices of potash—Continued.

	Prices.
MURIATE OF POTASH (80 TO 85 PER CENT; BASIS, 80 PER CENT)—Con.	
Apr. 2, 1917	$425.00-$450.00
July 2, 1917	350.00- 360.00
Oct. 1, 1917	326.00- 350.00
Dec. 31, 1917	350.00
April, 1918	345.00- 350.00
July 1, 1918	310.00
October, 1918	[illegible] 310.00
January, 1919	260.00- 310.00
April, 1919	260.00- 275.00
July, 1919	[illegible] 110
October, 1919	110.00
January, 1920	200.00- 240.00
April, 1920	200.00- 240.00
MURIATE OF POTASH (MINIMUM, 95 PER CENT; BASIS, 80 PER CENT).	
[Per ton, New York, spot.]	
Jan. 2, 1912	39.65
Apr. 1, 1912	39.65
July 1, 1912	40.15
Sept. 30, 1912	40.15
Dec. 30, 1912	40.15
Mar. 31 [illegible]	40.15
June 3[illegible]	40.15
Sept. 2[illegible]	40.15
Dec. 2[illegible]	40.15
Mar. 3[illegible]	40.75
June 2[illegible]	40.75
Sept. 2[illegible]	41.25
Dec. 2[illegible]	41.25
Mar. 2[illegible]	160.00
June 2[illegible]	250.00- 250.00
Sept. 2[illegible]	[12]
Jan. 3, [illegible]	[13]
Apr. 3, [illegible]	[13]
July 3, [illegible]	300.00- 310.00
Oct. 2, [illegible]	375.00
Jan. 1, [illegible]	375.00
Apr. 2, [illegible]	275.00
July 2, [illegible]	360.00
Oct. 1, 1917	[13]
Dec. 31, 1917	[13]
Apr. 1, 1918	[13]
July 1, 1918	325.00
October, 1918	260.00- 325.00
January, 1919	260.00- 325.00
April, 1919	260.00- 325.00
July, 1919	[13]
October, 1919	[13]
January, 1920	[13]
April, 1920	[13]
MURIATE OF POTASH (MINIMUM, 98 PER CENT; BASIS, 80 PER CENT).	
[Per ton, New York, spot.]	
Jan. 2, 1912	40.50
Apr. 1, 1912	40.50
July 1, 1912	41.00
Sept. 30, 1912	41.00
Dec. 30, 1912	41.00
Mar. 31, 1913	41.00
June 30, 1913	41.00
Sept. 29, 1913	41.00
Dec. 29, 1913	41.00
Mar 30, 1914	41.65
June 29, 1914	41.65
Sept. 28, 1914	42.15
Dec. 28, 1914	42.15
Mar 29, 1915	[illegible]
June 28, 1915	230.00- 260.00
Sept. 27, 1915	[13]
Jan. 3, 1916	[13]
Apr. 3, 1916	[13]
July 3, 1916	[13]

	Prices.
MURIATE OF POTASH) MINIMUM, 98 PER CENT; BASIS, 80 PER CENT)—Continued.	
Oct. 2, 1916	[13]
Je[illegible]17	[13]
A[illegible]17	[13]
Ju[illegible]17	[13]
O[illegible]17	[13]
D[illegible]1917	[13]
A[illegible]18	[13]
Ju[illegible]	$225.0[illegible]
O[illegible]1918	[illegible]260.00- 225.0[illegible]
Ja[illegible]1919	260.00- 225.0[illegible]
A[illegible]19	260.0[illegible]
Ju[illegible]	[13]
O[illegible]1919	[13]
Ja[illegible]1920	[13]
A[illegible]20	[13]
PERMANGANATE OF POTASH, U. S. P.	
[Per pound, New York, spot.]	
Jan. 1, 1912	.08[illegible] - 1[illegible]
Apr. 1, 1912	.08[illegible] - [illegible]
July 1, 1912	.08[illegible] - [illegible]
Sept. 30, 1912	.08[illegible] - [illegible]
Dec. 30, 1912	.08[illegible] - [illegible]
Mar. 31, 1913	.08[illegible] - [illegible]
June 30, 1913	.08[illegible] - [illegible]
Sept. 29, 1913	.08[illegible] - [illegible]
Dec. 29, 1913	.08[illegible] - [illegible]
Mar. 28, 1914	.08[illegible] - [illegible]
June 29, 1914	.08[illegible] - [illegible]
Sept. 28, 1914	.56 - [illegible]
Dec. 28, 1914	.14 - [illegible]
Mar. 29, 1915	.55 - [illegible]
June 28, 1915	.70 - [illegible]
Sept. 27, 1915	[illegible]
Jan. 3, 1916	[illegible]
Apr. 3, 1916	1.90 - 2.[illegible]
July 3, 1916	1.60 - 1.[illegible]
Oct. 2, 1916	1.75 - 2.[illegible]
Jan. 1, 1917	2.75 - 3.[illegible]
Apr 12, 1917 [14]	3.50 - 4.[illegible]
July 2, 1917	4.00 - 4.[illegible]
Oct. 1, 1917	4.00 - 4.25
Dec. 31, 1917	4.00 - 4.[illegible]
April, 1918	4.00 - 4.[illegible]
July 1, 1918	2.00 - 3.[illegible]
October, 1918	1.75 - 2.[illegible]
January, 1919	1.35 - 1.[illegible]
April, 1919	.60 - .[illegible]
July, 1919	.60 - .[illegible]
October, 1919	.65 - .[illegible]
January, 1920	.65 - .[illegible]
April, 1920	.70 - .[illegible]
CHLORATE OF POTASH, POWDERED.	
[Per pound, New York, spot.]	
Jan. 2, 1912	.08[illegible]
Apr 1, 1912	.08[illegible]
July 1, 1912	.08[illegible]
Sept. 30, 1912	.08[illegible]
Dec. 30, 1912	.08[illegible]
Mar. 31, 1913	.08[illegible]
June 30, 1913	.08[illegible]
Sept. 29, 1913	.08[illegible]
Dec 29, 1913	.07[illegible]
Mar. 30, 1914	.07[illegible]
June 29, 1914	.07[illegible]
Dec. 28, 1914	[illegible]
Mar. 29, 1915	.25 - [illegible]
June 28, 1915	.30 - [illegible]
Sept. 27, 1915	.34 - [illegible]
Jan. 3, 1916	.45 - [illegible]
Apr. 3, 1916	[illegible]

[12] Nominal.

Wholesale prices of potash—Continued.

	Prices.
CHLORATE OF POTASH, POWDERED—Continued.	
July 3, 1916	$0.53 -$0.70
Oct. 2, 1916	.48 - .70
Jan. 1, 1917	.65 - .70
Apr. 2, 1917	.60 - .70
July 2, 1917	.55 - .75
Oct. 1, 1917	.57½- .60
Dec. 31, 1917	.40 - .41
April, 1918	.41 - .42
July, 1918	.39 - .41
October, 1918	.40 - .41
January, 1919	.39 - .41
April, 1919	.40
July, 1919	.25 - .30
October, 1919	.20
January, 1920	.15
April, 1920	.15
PRUSSIATE OF POTASH, RED.	
[Per pound, New York, spot.]	
Jan. 1, 1912	.26 - .30
Apr. 1, 1912	.26 - .30
July 1, 1912	.26 - .60
Sept. 30, 1912	.28 - .32
Dec. 30, 1912	.33
Mar. 31, 1913	.33
June 30, 1913	.33
Sept. 29, 1913	.33
Dec. 29, 1913	.23
Mar. 28, 1914	.21½
June 29 ,1914	.21 - .23
Dec. 28, 1914	.55
Mar. 29, 1915	.55
June 28, 1915	1.25
Sept. 27, 1915	2.35
Jan. 3, 1916	5.00
Oct. 2, 1916	1.75 - 2.00
Jan. 1, 1917	2.50 - 3.00
July 2, 1917	2.75 - 2.90
Oct. 1, 1917	2.80 - 2.95
Dec. 31, 1917	2.65 - 3.00
Apr. 8, 1918	2.80 - 2.90
July, 1918	2.60 - 2.70
October, 1918	2.30 - 2.50
January, 1919	2.00 - 2.25
April, 1919	1.00 - 1.25
July, 1919	.75 - .80
October, 1919	1.10 - 1.20
January, 1920	1.00 - 1.10
April, 1920	1.00 - 1.10
PRUSSIATE OF POTASH, YELLOW.	
[Per pound, New York, spot.]	
Jan. 1, 1912	.13½- .13¾
Apr. 1, 1912	.13½- .13¾
July 1, 1912	.14
Sept. 30, 1912	.18 - .20
Dec. 30, 1912	.18 - .22
Mar. 31, 1913	.16½- .19
June 30, 1913	.16 - .18
Sept. 29, 1913	.15½- .17½
Dec. 29, 1913	.13¾
Mar. 28, 1914	.13 - .13½
June 29, 1914	.12½- .12¾
Sept. 28, 1914	.34 - .36
Dec. 28, 1914	.22 - .24
Mar. 29, 1915	.42 - .48
June 28, 1915	.75 - .90
Sept. 27, 1915	.82½- .85
Jan. 3, 1916	.90 - 1.00
Apr. 3, 1916	1.75 - 1.80
July 3, 1916	1.20 - 1.30
Oct. 2, 1916	.65 - .75
Jan. 1, 1917	.92 - .95
July 2, 1917	1.00 - 1.05
Oct. 1, 1917	1.25

	Prices.
PRUSSIATE OF POTASH, YELLOW—Continued.	
Dec. 31, 1917	$1.25 -$1.30
Apr. 8, 1918	1.25 - 1.27
July, 1918	1.05 - 1.10
October, 1918	.95 - 1.00
January, 1919	.75 - .80
April, 1919	.50 - .55
July, 1919	.25 - .30
October, 1919	.45 - .55
January, 1920	.36 - .38
April, 1920	.35 - .38
SULPHATE OF POTASH (90 TO 95 PER CENT; BASIS, 90 PER CENT).	
[Per ton.]	
Jan. 1, 1912	46.30
Apr. 1, 1912	46.30
July 1, 1912	46.80
Sept. 30, 1912	46.80
Dec. 30, 1912	46.80
Mar. 31, 1913	46.80
June 30, 1913	46.80
Sept. 29, 1913	46.80
Dec. 29, 1913	46.80
Mar. 28, 1914 [13]	47.57
June 29, 1914	47.57
Sept. 28, 1914	48.07
Dec. 28, 1914	48.07
Mar. 29, 1915	140.00
June 28, 1915	205.00
Sept. 27, 1915	205.00- 210.00
Jan. 3, 1916	440.00
Apr. 3, 1916	325.00- 350.00
July 3, 1916	275.00- 300.00
Oct. 2, 1916	275.00- 300.00
Jan. 1, 1917	275.00- 300.00
Apr. 2, 1917	275.00- 300.00
July 2, 1917	275.00- 300.00
Oct. 1, 1917	300.00
Dec. 31, 1917	350.00- 400.00
Apr. 1, 1918	375.00- 400.00
July 1, 1918	350.00
October, 1918	325.00- 350.00
January, 1919	300.00
April, 1919	225.00
July, 1919	(12)
October, 1919	(12)
January, 1920	(12)
April, 1920	360.00
DOUBLE MANURE SALT (48 TO 53 PER CENT; BASIS, 48 PER CENT).	
[Per ton, New York, spot.]	
Jan. 1, 1912	24.45
Apr. 1, 1912	24.45
July 1, 1912	24.95
Sept. 30, 1912	24.95
Dec. 30, 1912	24.95
Mar. 31, 1913	24.95
June 30, 1913	24.95
Sept. 29, 1913	24.95
Dec. 29, 1913	24.95
Mar. 29, 1914 [14]	25.04
June 29, 1914 [14]	25.04
Sept. 28, 1914	25.54
Dec. 28, 1914	25.54
Mar. 29, 1915 [14]	55.00
June 28, 1915 [14]	57.00
Sept. 27, 1915	105.00
Jan. 3, 1916	105.00
Apr. 3, 1916	105.00
July 3, 1916	105.00
Oct. 2, 1916	105.00
Jan. 1, 1917	105.00
Apr. 2, 1917	105.00
July 2, 1917	105.00
Oct. 1, 1917	(15)

[13] Nominal.
[14] In bags.
[15] In bags.
[16] Nominal from October, 1917, to April, 1920.

Wholesale prices of potash.

	Prices.
MANURE SALT (MINIMUM, 20 PER CENT K_2O IN BULK).	
[Per ton, New York, spot.]	
Jan. 1, 1912	$13 30
Apr. 1, 1912	13.30
July 1, 1912	13.50
Sept. 30, 1912	13.50
Dec. 30, 1912	13.50
Mar. 31, 1913	13.50
June 30, 1913	13.50
Sept. 29, 1913	13.50
Dec. 29, 1913	13.50
Mar. 28, 1914	13.58
June 29, 1914	13.58
Sept. 28, 1914	13.78
Dec. 28, 1914	13.78
Mar. 29, 1915	27.00
June 28, 1915	50.00
Sept. 27, 1915	60.00
Jan. 3, 1916	60.00
Apr. 3, 1916	$50.00- 60.00
July 3, 1916	50.00- 60.00
Oct. 2, 1916	50.00- 60.00
Jan. 1, 1917	50.00- 60.00
Apr. 2, 1917 [14]	50.00- 60.00
July 2, 1917	50.00- 60.00
Oct. 1, 1917	(15)
HARD SALT (MINIMUM, 16 PER CENT K_2O IN BULK).	
[Per ton, New York, spot.]	
Jan. 1, 1912	10.65
Apr. 1, 1912	10.65
July 1, 1912	10.85
Sept. 30, 1912	10.85
Dec. 30, 1912	10.85
Mar. 31, 1913	10.85
June 30, 1913	10.85
Sept. 29, 1913	10.85
Dec. 29, 1913	10.85
Mar. 28, 1914	10.87
June 29, 1914	10.87
Sept. 28, 1914	11.07
Dec. 28, 1914	11.07
June 28, 1915	40.00- 50.00
Sept. 27, 1915	40.00- 50.00
Jan. 3, 1916	40.00- 50.00
Apr. 3, 1916	40.00- 50.00
July 3, 1916	40.00- 50.00
Oct. 2, 1916	40.00- 50.00
Jan. 1, 1917	40.00- 50.00
July 2, 1917	40.00- 50.00
Oct. 1, 1917	(15)
KAINITE (MINIMUM, 12.4 PER CENT K_2O IN BULK).	
[Per ton, New York, spot.]	
Jan. 1, 1912	8.25
Apr. 1, 1912	8.25
July 1, 1912	8.45
Sept. 30, 1912	8.45
Dec. 30, 1912	8.45
Mar. 31, 1913	8.45
June 30, 1913	8.45
Sept. 29, 1913	8.45

	Prices.
KAINITE (MINIMUM, 12.4 PER CENT K_2O IN BULK)—Contd.	
Dec. 29, 1913	$8.45
Mar. 28, 1914	8.45
June 29, 1914	8.45
Sept. 28, 1914	8.45
Dec. 28, 1914	8.45
Sept. 27, 1915	$40.00- 50.00
Jan. 3, 1916	40.00- 50.00
Apr. 3, 1916	40.00- 50.00
July 3, 1916	40.00- 50.00
Oct. 2, 1916	40.00- 50.00
Jan. 1, 1917	40.00- 50.00
July 2, 1917	40.00- 50.00
Oct. 1, 1917	(16)
SALTPETER, CRUDE.[16]	
[Per pound, New York, spot.]	
Jan. 1, 1912	.04½- .07
Apr. 1, 1912	.04½- .07
July 1, 1912	.04½- .05
Sept. 30, 1912	.05
Dec. 30, 1912	.05
Mar. 31, 1913	.07
June 30, 1913	.13
Sept. 29, 1913	.04½- .07
Dec. 29, 1913	.04½- .04½
Mar. 30, 1914	.04½ .05
June 29, 1914	.04½ .06
SALTPETER, REFINED.	
[Per pound, New York, spot.]	
Jan. 1, 1912	.04½- .06
Apr. 1, 1912	.04½- .06
July 1, 1912	.05 - .06
Sept. 30, 1912	.05 - .06
Dec. 30, 1912	.05½- .06
Mar. 31, 1913	.05½- .07
June 30, 1913	.05½- .07
Sept. 29, 1913	.05½- .06
Dec. 29, 1913	.05½- .07
Mar. 30, 1914	.04½- .05
June 29, 1914	.04½- .05
Sept. 28, 1914	.09 - .10
Dec. 28, 1914	.07 - .08
Mar. 29, 1915	.09½- .10
June 28, 1915	.15½- .16
Sept. 27, 1915	.18 - .19
Jan. 3, 1916	.35 - .36
Apr. 3, 1916	.35 - .36
July 3, 1916	.29½- .30
Oct. 2, 1916	.28 - .30
Jan. 1, 1917	.31 - .35
Apr. 2, 1917	.31 - .39
July 2, 1917	.31 - .39
Dec. 31, 1917	(17)
Apr. 8, 1918	.31 - .31½
July, 1918	.31 - .31½
October, 1918	.31 - .31½
January, 1919	.31 - .31½
April, 1919	.21 - .25
July, 1919	.16 - .16½
October, 1919	.14½- .16
January, 1920	.14½- .16
April, 1920	.14½- .16

[14] In bags.
[15] Nominal from October, 1917, to April, 1920.
[16] Not listed since 1914.
[17] Not listed.

Rates of duty on individual salts.

POTASH, BICARBONATE OF, REFINED.

Act of—	Paragraph.	Tariff classification or description.	Rates of duty, specific and ad valorem.
1883.....	73	Potash, bicarbonate of, or supercarbonate of, and saleratus, calcined or pearl-ash.....	1½ cents per pound.
1890.....	76	All chemical compounds and salts, n. s. p. f.....	25 per cent ad valorem.
1894.....	60	.....do.....	Do.
1897.....	3	.....do.....	Do.
1909.....	3	All chemical compounds, mixtures, and salts, n. s. p. f....	Do.
1913.....	64	Potash, bicarbonate of, refined.....	½ cent per pound.

POTASH, CARBONATE OF, CRUDE (OR BLACK SALTS).

1883.....	63	Potash: crude, carbonate of, or fused.....	20 per cent ad valorem.
1890.....	685	Potash, crude, carbonate of, or "black salts".....	Free.
1894.....	595	.....do.[1].....	Do.
1897.....	644	Potash, crude, or "black salts"; carbonate of potash, crude or refined.	Do.
1909.....	655	.....do.....	Do.
1913.....	580	Potash, crude, or "black salts"; carbonate of.....	Do.

POTASH, CHLORATE OF.

1883.....	64	Potash, chlorate of.....	3 cents per pound.
1890.....	685	Chlorate of potash.....	Free.
1894.....	595	.....do.....	Do.
1897.....	63	Potash, chlorate of.....	2½ cents per pound.
1909.....	61	Chlorate of potash.....	2 cents per pound.
1913.....	64	Potash, chlorate of.....	½ cent per pound.

POTASH, CHROMATE AND BICHROMATE OF.

1883.....	48	Chromate of potash.....	3 cents per pound.
	49	Bichromate of potash.....	Do.
1890.....	69	Potash, bichromate and chromate of.....	Do.
1894.....	54	.....do.....	25 per cent ad valorem.
1897.....	62	.....do.....	3 cents per pound.
1909.....	60	.....do.....	2½ cents per pound.
1913.....	64	Potash, chromate and bichromate of.....	1 cent per pound.

POTASH, CYANIDE OF.

1883.....	92	All chemical compounds and salts, by whatever name known, and not specially enumerated or provided for in this act.	25 per cent ad valorem.
1890.....	76	All chemical compounds and salts, n. s. p. f.....	Do.
1894.....	60	.....do.....	Do.
1897.....	66	Cyanide of potassium.....	12½ per cent ad valorem.
1909.....	64	.....do.....	Do.
1913.....	580	Potash, cyanide of.....	Free.

POTASH, HYDRATE OF.

1883.....	63	Caustic potash (no specific provision for hydrate of potash).	20 per cent ad valorem.
1890.....	70	Potash, caustic or hydrate of, refined, in sticks or rolls.....	1 cent per pound.
	685	Caustic potash, or hydrate of, not including refined, in sticks or rolls.	Free.
1894.....	595	Caustic potash, or hydrate of, including refined, in sticks or rolls.	Do.
1897.....	63	Potash, caustic or hydrate of, refined, in sticks or rolls.....	1 cent per pound.
	644	Potash, hydrate of, or caustic potash, not including refined, in sticks or rolls.	Free.
1909.....	61	Caustic, or hydrate of potash, refined, in sticks or rolls.....	1 cent per pound.
	655	Potash, hydrate of, or caustic potash, not including refined, in sticks or rolls. Where there is less than 50 per cent of caustic potash or more than 10 per cent of soda, dutiable as chemical mixture or combination of alkalies under paragraph 3. (Dept. Order, T. D. 32440.)	Free.
1913.....	580	Potash, hydrate of, when not containing more than 15 per cent of caustic soda.	Do.
	5	Potash, hydrate of, when containing more than 15 per cent of caustic soda is not specifically provided for and falls within paragraph 5 for chemical compounds or salts, n. s. p. f.	15 per cent ad valorem.

[1] Carbonate of potash was held under the act of 1894 to include both the impure and refined. (T. D. 30, G. A. 3604; 19067, G. A. 4087; following United States *v.* Giese, 83 Fed., 692.)

Rates of duty on individual salts—Continued.

POTASH, HYDRIODATE OF.

Act of—	Paragraph.	Tariff classification or description.	Rates of duty, specific and ad valorem.
1883	65	Potash, hydriodate	50 cents a pound.
1890	71	do	Do.
1894	55	do	25 cents a pound.
1897	64	do	Do.
1909	62	do	Do.
1913	5	All chemical and medicinal compounds, preparations, mixtures and salts, and combinations thereof, n. s. p. f.	15 per cent ad valorem.

POTASH, IODATE OF.

1883	65	Potash, iodate	50 cents per pound.
1890	71	do	Do.
1894	55	do	25 cents per pound.
1897	64	do	Do.
1909	62	do	Do.
1913	5	All chemical and medicinal compounds, preparations, mixtures and salts, and combinations thereof, n. s. p. f.	15 per cent ad valorem.

POTASSIUM IODIDE.

1883	65	Potash, iodide	50 cents per pound.
1890	71	do	Do.
1894	55	do	25 cents per pound.
1897	64	do	Do.
1909	62	do	Do.
1913	38	Potassium iodide	15 cents per pound.

POTASH, MURIATE OF.

1883	627	Potash, muriate of	Free.
1890	685	Muriate of potash	Do.
1894	595	do	Do.
1897	644	do	Do.
1909	655	do	Do.
1913	580	Potash, muriate of	Do.

POTASH, NITRATE OF, CRUDE.

1883	68	Potash, nitrate of, or saltpeter, crude	1 cent per pound.
1890	685	Nitrate of potash, or saltpeter, crude	Free.
1894	595	do	Do.
1897	644	do	Do.
1909	655	do	Do.
1913	580	Potash, nitrate of, or saltpeter, crude	Do.

POTASH, NITRATE OF, REFINED.

1883	69	Potash, nitrate of, or refined saltpeter	1½ cents per pound.
1890	72	Potash, nitrate of, or saltpeter, refined	1 cent per pound.
1894	56	do	½ cent per pound.
1897	65	do	Do.
1909	63	Nitrate of potash, or saltpeter, refined	Do.
1913	64	Potash, nitrate of, or saltpeter, refined	$7 per ton.

POTASH, PERMANGANATE OF.

1883	92	All chemical compounds and salts, by whatever name known and not specially enumerated or provided for in this act.	25 per cent ad valorem.
1890	76	All chemical compounds and salts, n. s. p. f.	Do.
1894	60	do	Do.
1897	3	do	Do.
1909	3	All chemical compounds, mixtures, and salts, n. s. p. f.	Do.
1913	64	Potash, permanganate of	1 cent per pound.

Rates of duty on individual salts—Continued.

POTASH, PRUSSIATE OF, RED.

Act of—	Paragraph.	Tariff classification or description.	Rates of duty, specific and ad valorem.
1883	66	Potash, prussiate of, red	10 cents per pound.
1890	73	do	Do.
1894	57	do	25 per cent ad valorem.
1897	66	do	8 cents per pound.
1909	64	do	Do.
1913	64	do	2 cents per pound.

POTASH, PRUSSIATE OF, YELLOW.

1883	67	Potash, prussiate of, yellow	5 cents per pound.
1890	73	do	Do.
1894	57	do	25 per cent ad valorem.
1897	66	do	4 cents per pound.
1909	64	do	Do.
1913	64	do	1½ cents per pound.

POTASH, SULPHATE OF.

1883	70	Potash, sulphate of	20 per cent ad valorem.
1890	685	Sulphate of potash, crude or refined	Free.
1894	595	do	Do.
1897	644	do	Do.
1909	655	do	Do.
1913	580	Potash, sulphate of	Do.

TARTRATE OF SODA AND POTASSA AND ROCHELLE SALTS.

1883	29	Soda and potassa tartrate, or Rochelle salts	3 cents per pound.
1890	92	Tartrate of soda and potassa, or Rochelle salts	Do.
1894	75	do	2 cents per pound.
1897	6	do	4 cents per pound.
		Containing more than 90 per cent of bitartrate of potash.	5 cents per pound.
1909	6	Tartrate of soda and potassa, or Rochelle salts	3 cents per pound.
		Containing more than 90 per cent of bitartrate of potash.	4 cents per pound.
1913	8	Rochelle salts, or tartrate of soda and potassa	2½ cents per pound.

KELP.

1883	540	Kelp	Free.
1890	623	do	Do.
1894	524	do	Do.
1897	589	do	Do.
1909	601	do	Do.
1913	528	do	Do.

KAINITE.

1883	616	Kyanite or cyanite, and kainite	Free.
1890	625	do	Do.
1894	526	do	Do.
1897	591	do	Do.
1909	604	do	Do.
1913	525	do	Do.

COURT AND TREASURY DECISIONS.

PERMANGANATE OF POTASH.

Permanganate of potassa, used almost exclusively as a disinfectant, was held dutiable under the provision in the act of 1861 for "all other salts and preparations of salts n. o. p. f." (Dept. Order, T. D. 1545.)

POTASSIUM.

Merchandise described as "the elementary substance known as potassium, the metallic base of potash," was held dutiable as "metal, unwrought." (Appeal of Contanseau Rapid Foreign Express Co., T. D. 9324.)

CYANIDE OF POTASSIUM.

Cyanide of potassium was held dutiable as a chemical salt not derived from coal tar under paragraph 60 of the act of 1894, and not exempt from duty as a coal-tar product or preparation under paragraph 443. (G. A. 3681, T. D. 17633.)

A mixture of cyanide of potassium and cyanide of sodium, known commercially as cyanide of potassium, was held dutiable as cyanide of potassium under paragraph 66 of the act of 1897, and not as a chemical salt, the provision being construed as not limited to the pure potassium cyanide. (G. A. 4777, T. D. 22521.)

This decision was followed under the act of 1909, notwithstanding the Government's contention that paragraph 3 of that act applied only to the pure cyanide of potassium used in medicine, as by virtue of the pure-food law the impure article is not permitted to be labeled or sold as cyanide of potassium. (Abstract 23365, T. D. 30645, followed in Abstract 23593, T. D. 30733; Abstract 24026, T. D. 30969; Abstract 24475, T. D. 31165; Abstract 24568, T. D. 31207; Abstract 27170, T. D. 32031; Abstract 30514, T. D. 32943; but not in Abstract 35678, T. D. 34468.)

An article containing 22 per cent of cyanide of potassium, 57 per cent of cyanide of sodium, and 21 per cent of other substances was held on the testimony to be commercially cyanide of potassium within paragraph 64 of the act of 1909, and therefore dutiable at 12½ per cent ad valorem and not at 25 per cent under paragraph 3 as a chemical compound, mixture, or salt. (Abstract 29723, T. D. 32823; Abstract 30109, T. D. 32858; G. A. 7571, T. D. 34495; Abstract 36943, T. D. 34933.)

But a substance composed of 10 per cent cyanide of potash and the remainder cyanide of soda, classified as a chemical compound, was held not dutiable as cyanide of potassium. (Abstract 36046, T. D. 34609.)

G. A. 7571, T. D. 34495, supra, was also followed under the act of 1913. (Abstract 37164.)

CARBONATE OF POTASH.

An article consisting of carbonate, sulphate, and chloride of potassa, together with insoluble matter, containing more than 30 per cent of free potash and constituting the crude carbonate of potash, was held to be different from the black salts of commerce, which was declared to be the crude caustic potash from which the carbonate of

potash is made by one process, whereas the caustic potash of commerce is made by another process. Classification was made under the Revised Statutes as an unenumerated manufactured article. (Dept. Order, T. D. 5096.)

Merchandise described as "a species of crude potash" was held dutiable under the act of 1883 as "potash, crude," and not exempt under the provision for "aniline salts or black salts and black tares," not being known in commerce as black salts and admittedly not an aniline salt. (Appeal, T. D. 8601.)

Carbonate of potash, crude, somewhat advanced toward the condition of pearlash and not so crude or dark colored as black salts, was held exempt from duty as crude carbonate of potash under the act of 1890 and not dutiable as refined. (G. A. 1249, T. D. 12565.)

Refined carbonate of potash was held exempt from duty under the provision in paragraph 595 of the act of 1894 for "potash, crude, carbonate of, or 'black salts,'" and not dutiable as a chemical salt. The Government contended that the word "crude" in paragraph 595 qualified the phrase "carbonate of, or 'black salts,'" and that the phrase "potash, crude, carbonate of, or 'black salts'" covered only one product. The Board of General Appraisers held that the said terms should be applied distributively so as to provide for crude potash, carbonate of potash, and black salts. Its view was sustained by the Circuit Court for the Southern District of New York and by the Circuit Court of Appeals for the Second Circuit. (Dept. Order, T. D. 17380, 17381; G. A. 3604, T. D. 17430; U. S. *v.* Giese, 78 Fed., 605, T. D. 17900; 83 Fed., 692, T. D. 18810; G. A. 4087, T. D. 19067, overruling T. D. 17027.)

BICARBONATE OF POTASH.

Bicarbonate of potash was held dutiable under the Revised Statutes as a medicinal preparation. (Dept. Order, T. D. 4117.)

Bicarbonate of potash was held dutiable as a chemical salt under paragraph 76 of the act of 1890. (G. A. 548, T. D. 11189.)

CAUSTIC POTASH.

Caustic potash, or hydrate of potash, was held not to assimilate in character and use to pearl-ash and to be dutiable as an unenumerated article under the Revised Statutes. (Dept. Order, T. D. 3940. Compare T. D. 420, holding calcined potash or hydrate of potash similar in character and use to pearlash and dutiable accordingly.)

So-called caustic potash, containing less than 50 per cent of caustic potash or more than 10 per cent of soda, was held dutiable under the act of 1909 as a chemical mixture or a combination of alkalies and not exempt from duty as caustic potash. (Dept. Order, T. D. 32440.)

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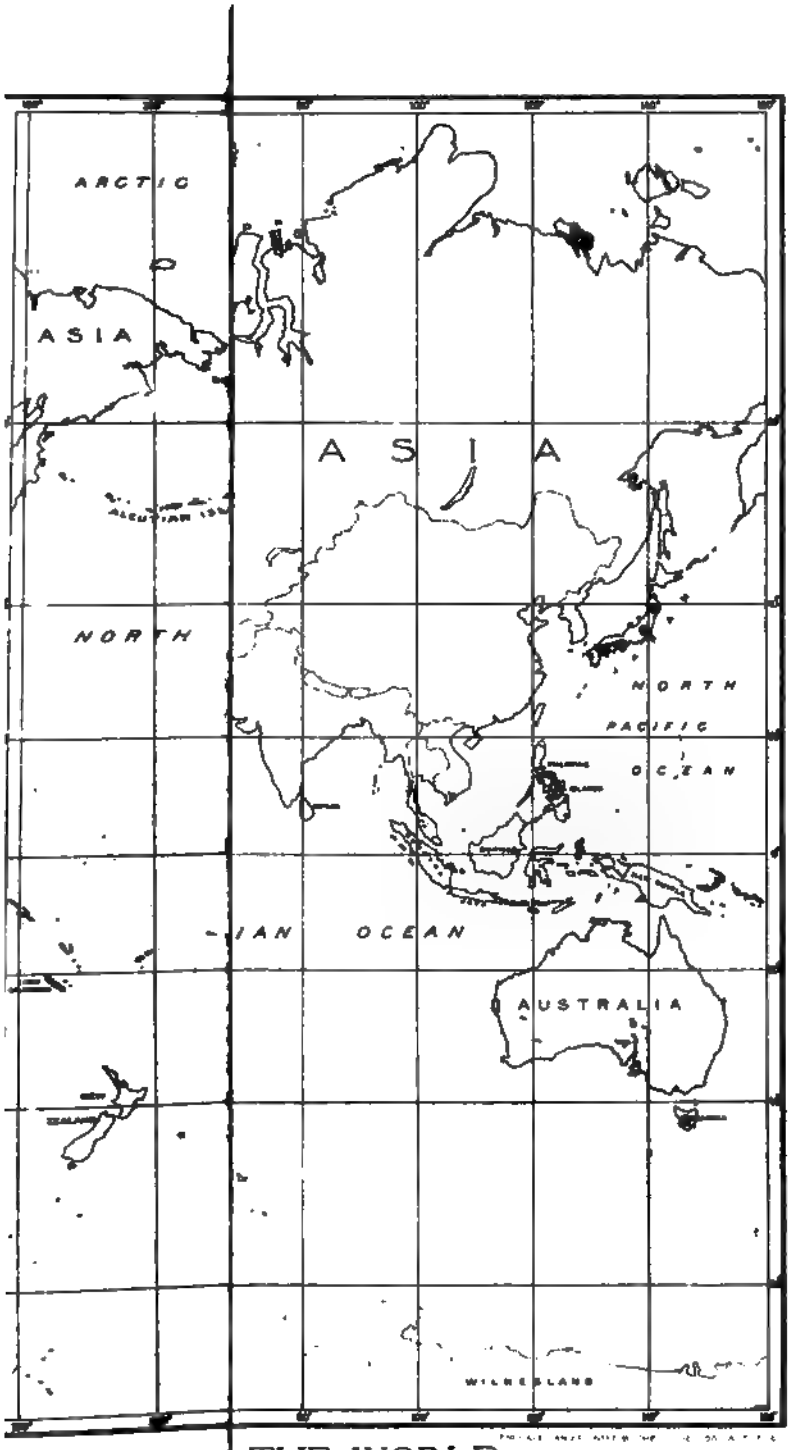
PYRITES AND SULPHUR



THE WORLD

LEGEND

Red dots—Districts that have produced

. S. Geological Sur

PYRITES AND SULPHUR.

SUMMARY.

MPORTANCE OF THE INDUSTRIES.

The only important use for pyrites is as a raw material in the anufacture of sulphuric acid, which is necessary for the manufacure of high explosives in time of war, and which is also one of the ost important products of the chemical industry in times of peace. the manufacture of sulphuric acid, however, it is feasible and in ost cases advantageous to use native sulphur rather than pyrites, less pyrites can be secured at a very much lower price per unit of lphur than native sulphur, which has been the case in the past.

OREIGN AND DOMESTIC RESOURCES.

Spain and Portugal possess the largest known deposits of pyrites. ese two countries supply about three-fourths of the world's mands. Spain is the larger producer and Spanish ore has long en considered the most desirable pyrites for sulphuric-acid manucture because of its uniformity and high content of sulphur. It so contains a small percentage of copper which may be recovered a by-product. In fact, copper-bearing pyrites is used as a copper e in Spain; the residue left after the copper is removed is still itable for the manufacture of sulphuric acid.

There are extensive deposits of pyrites in the western sections of e United States. The distance of these deposits from the chief nsuming districts, which are east of the Mississippi River, prevents em from competing with Spanish pyrites under normal conditions. ior to the war the domestic production of pyrites was about 340,000 g tons; about one-half of the output was supplied by Virginia. oduction during the war was greatly stimulated by the large war mand for sulphuric acid. The output in 1917 and 1918 was about),000 tons, or a 35 per cent increase over the prewar production. is increase has been attained primarily by increased production m existing mines rather than from any extensive developments of w deposits. As a general rule the domestic product has a lower phur content than the Spanish ore.

OMESTIC SUPPLIES.

About 1,250,000 long tons of pyrites are normally consumed in the ited States each year in the manufacture of sulphuric acid. Prior the war over 70 per cent of the consumption was imported, chiefly

from Spain and Portugal. Canada supplied practically all of the remainder of the imports.

The war more than doubled the demand for sulphuric acid, and at the same time interfered with the importation of Spanish pyrites. The necessary raw material for sulphuric-acid manufacture was obtained in part by a 35 per cent increase in the domestic production of pyrites, but mainly by an increased output of native sulphur. Before the war the quantity of sulphur used in the manufacture of sulphuric acid was very small, but during 1918 the quantity of sulphur used for this purpose was at least equal to the quantity of pyrites used. Because of the difference in sulphur content, about twice as much sulphuric acid was produced from sulphur as from pyrites.

FUTURE COMPETITIVE CONDITIONS.

Pyrites mines in the vicinity of sulphuric-acid plants can exist in spite of free importations. But the possibility of competition from domestic sulphur is a serious threat to the prosperity of domestic pyrites producers generally. There are strong indications that if the domestic sulphur producers so desire they can still further reduce the price of sulphur to a point at which it is problematical whether domestic or imported pyrites can compete with it, unless the domestic mines are located near acid plants. Should the sulphur producers remain in the sulphuric-acid market, domestic pyrites producers could not survive. The competition between domestic sulphur producers and foreign pyrites producers is complicated by the fact that Spanish pyrites usually carries about 3 per cent of copper. The copper is first leached from the ore and the residual pyrites which is still suitable for sulphuric-acid manufacture may be sold at a very low price. The extent to which this residual pyrites will compete with domestic crude sulphur is problematical.

It is possible that the sulphur producers by restricting their business to prewar channels, which did not include the sulphuric-acid business, and by maintaining the price of sulphur at the prewar level of $22 per ton, f. o. b. New York, could realize larger profits than by reducing the price of sulphur so that it could compete with pyrites in supplying the sulphuric-acid manufacturers. But this policy now seems unlikely because the competitive conditions in the domestic sulphur industry have changed greatly during the war. The Frasch patents owned by the Union Sulphur Co., which formerly gave this firm a practical monopoly of the sulphur trade, have been declared void; the Freeport Sulphur Co. has developed a large production during the war, and in March, 1919, a third company, the Texas Gulf Sulphur Co., began producing sulphur on a large scale. Sharp competition between these three companies has caused a drop in the price of sulphur. Although domestic pyrites producers face competition from Spanish pyrites, the competition which they face from American sulphur appears to be more serious.

changeably in the same burner; that is, each grade requires a special type of burner. The lump ore commands the higher price, but, of course, it is more difficult to obtain a lump ore with as high a sulphur content as that of fines. As a result only a few mines can furnish lump ore and maintain a high enough sulphur content, whereas suitable fines may be obtained even from deposits in which the pyrites is sparsely disseminated.

Spanish pyrites, in addition to being classed as "lump" or "fines," is also divided into the following three grades:

1. Crude noncopper-bearing ore, which is exported from Spain just as it is taken from the mines.

2. Crude copper-bearing ore. After the sulphur has been burned from this ore in the manufacture of sulphuric acid, the copper is recovered from the residue, which is called pyrite cinder.

3. Washed ore, a copper-bearing ore from which the copper has been leached in Spain. The residual pyrites containing a small percentage of copper is exported from Spain. This grade comes in both "lump" and "fines" but especially in the latter.

SULPHUR CONTENT OF PYRITES ORE.

The following quotation relating to the sulphur content of domestic pyrites is taken from the chapter on Sulphur and Pyrites in 1918 by Philip S. Smith, Mineral Resources, United States Geological Survey:

"Of the total quantity of pyrites produced, 199,472 tons were reported to be lump and 265,022 tons were fines or concentrates. The total sulphur content of the lump ore was 74,504 tons, or an average of slightly more than 37 per cent of sulphur, and that of the fines or concentrates was 110,984 tons, or an average of about 42 per cent of sulphur."

Spanish pyrites as mined contains not less than 44 per cent of sulphur and runs as high as 52 per cent. Spanish ore on an average contains 48 to 50 per cent of sulphur. Practically all Spanish ore contains copper, the quantity ranging from 1½ to 2½ per cent, and 3 per cent may be taken as the maximum of copper ordinarily occurring in Spanish pyrites. In Spain the process of leaching the copper from pyrites (see p. 221) leaves the residual pyrites with the sulphur content increased by about 2 per cent above the content prior to the leaching. This is due to the extraction of impurities along with the copper.

IMPORTANT USES.

Practically the only use of pyrites is for the manufacture of sulphuric acid, which is considered the most important of chemical commodities and which is an essential material for the manufacture of acid phosphate for fertilizers. About 1,250,000 long tons of pyrites are normally consumed each year in the United States for the manufacture of sulphuric acid. Prior to the war pyrites was

making and subsequent copper extraction permits a return of the capital investment in a much shorter period. Washed pyrites, which contains a very small per cent of copper (less than 0.5 per cent) or Spanish and domestic copper-free pyrites is usually sold outright to the sulphuric-acid manufacturer. Even in this case, the pyrites cinder may be sold as metallic paint or as iron ore, but at a lower price than cinder which has been treated and sintered.

The revenue resulting from the copper value of pyrites cinder, the value of the cinder itself as iron ore, and the fact that "washed pyrites ore" is a by-product of copper production in Spain, greatly complicate the competitive situation between sulphur and pyrites in supplying the requirements of sulphuric-acid manufacturers.

Ocean freight rates on Spanish pyrites to this country prior to the war were from 8 to 10 shillings ($1.95 to $2.43) per long ton. The Spanish ore is shipped from Seville or Heulva and the Portuguese product from Pamona. During the war rates increased and in the early part of 1920 were about 14 shillings ($3.40) per long ton. The larger part of the pyrites is shipped in cargoes of 5,000 to 7,000 tons

DOMESTIC PRODUCTION.

Geographical distribution.—There are four main areas containing promising pyrites deposits in the United States: (1) The Appalachian Mountain region; (2) the interior States, where it is a by-product of coal mining; (3) the Rocky Mountain States; and (4) the Coast Ranges. More than three-fourths of the domestic consumption of pyrites is in the region east of the Mississippi River. As a consequence the western deposits can not compete in the eastern market against Spanish pyrites and can not be profitably utilized except for local demands.

Prior to 1915 Virginia produced about 45 per cent of the domestic output of pyrites. During the years 1915, 1916, and 1917 the quantity of pyrites supplied by Virginia represented about 35 per cent of the total production. This decrease was not due to a smaller production in Virginia but to an increase in the output from other States. In 1918 only 30 per cent of the total output of pyrites was credited to Virginia. This State, however, has always been the leading producer of pyrites. California is the next largest producer and the output in this State during the war increased until it approached that of Virginia. During the war Virginia and California supplied from 65 to 70 per cent of the total domestic production until 1918, when New York was credited with a substantial output of pyrites.

The following table shows the production of pyrites in the United States, and also the unit value at the mine:

Production of pyrites in United States, by States—Calendar years.

[From Mineral Resources, U. S. Geological Survey.]

State.	1910			1911			1912		
	Quantity (long tons).	Value.	Unit value.	Quantity (long tons).	Value.	Unit value.	Quantity (long tons).	Value.	Unit value.
California	27,158	$129,504	$4.77	48,415	$182,787	$3.78	61,812	$201,453	$3.26
Illinois	8,541	28,159	3.30	17,441	47,020	2.70	27,008	62,980	2.33
Indiana	(1)	(1)	.....	(1)	(1)	.....	1,462	5,684	3.89
Ohio	3,766	12,831	3.41	6,471	18,017	2.78	14,487	43,853	3.03
Virginia	140,106	525,437	3.75	150,800	558,494	3.70	162,478	621,219	3.82
Wisconsin	12,555	49,467	3.94	12,893	50,025	3.88	17,898	70,518	3.94
Other States	49,486	232,580	4.70	65,438	308,528	4.71	65,783	328,552	4.99
Total	241,612	977,978	4.05	301,458	1,164,871	3.86	350,928	1,334,259	3.80

State.	1913			1914			1915		
	Quantity (long tons).	Value.	Unit value.	Quantity (long tons).	Value.	Unit value.	Quantity (long tons).	Value.	Unit value.
California	70,536	$218,525	$3.10	71,272	$235,129	$3.30	132,270	$496,111	$3.75
Georgia	11,110	55,094	4.96	(1)	(1)	.....	(1)	(1)	.....
Illinois	11,246	31,966	2.84	22,538	59,079	2.62	14,849	22,476	1.51
Indiana	1,242	3,115	2.51	1,710	5,281	3.09	972	3,080	3.17
Ohio	13,622	34,998	2.57	7,279	19,718	2.71	10,857	27,404	2.52
Virginia	148,259	587,041	3.96	141,276	556,091	3.94	145,050	729,644	5.03
Wisconsin	25,328	94,727	3.74	14,188	78,460	5.53	13,985	43,354	3.10
Other States	59,995	260,618	4.34	78,399	329,588	4.20	76,141	352,864	4.63
Total	341,338	1,286,084	3.77	336,662	1,283,346	3.81	394,124	1,674,933	4.25

State.	1916			1917			1918		
	Quantity (long tons).	Value.	Unit value.	Quantity (long tons).	Value.	Unit value.	Quantity (long tons).	Value.	Unit value.
California	145,762	$565,699	$3.88	115,817	$333,501	$2.88	111,861	$501,541	$4.48
Colorado	(1)	(1)	.....	(1)	(1)	.....	18,817	115,712	6.15
Georgia	(1)	(1)	.....	23,242	155,560	6.69	31,315	268,797	8.58
Illinois	20,482	51,432	2.51	24,596	89,998	3.66	24,369	85,659	3.52
Missouri	(1)	(1)	.....	(1)	(1)	.....	7,674	69,202	9.02
New York	(1)	(1)	.....	(1)	(1)	.....	63,982	422,958	6.61
Ohio	13,551	36,114	2.66	13,218	29,557	2.24	9,845	40,215	4.08
Virginia	148,502	925,243	6.23	170,382	1,378,043	8.09	143,427	841,177	5.86
Other States	95,259	387,214	4.06	115,407	498,776	4.32	53,204	299,254	5.62
Total	423,556	1,965,702	4.64	462,662	2,485,435	5.37	464,494	2,644,515	5.69

[1] Included in "Other States."

PRODUCTION AND CONSUMPTION.

The domestic production of pyrites prior to the war was about 340,000 long tons, valued at about $1,250,000. The production was greatly stimulated during the war by the large increased demand for sulphuric acid. In 1917 the production increased to 462,662 long tons, valued at $2,485,435. This represents a 35 per cent increase over the prewar production, but only a 10 per cent increase over the

production in 1916. The increase was due primarily to the increased output of existing mines rather than to developments of new deposits. The domestic production in 1918 increased slightly to 464,494 long tons, valued at $2,644,515.

The domestic production prior to the war supplied about 25 per cent of the total consumption of pyrites in the United States. In 1917 the domestic production supplied about 32 per cent of the consumption in the United States and in 1918 about 48 per cent. The increase is due, chiefly, to a decrease in imports rather than to a marked increase in domestic output. The following table shows the production, importation, and consumption of pyrites since 1910:

Production, imports, and consumption of pyrites in the United States.

[From Mineral Resources, U. S. Geological Survey.]

Calendar year.	Production.	Imports.	Consumption.	Calendar year.	Production.	Imports.	Consumption.
	Long tons.	*Long tons.*	*Long tons.*		*Long tons.*	*Long tons.*	*Long tons.*
1910.....	241,612	803,551	1,045,163	1915.....	394,124	964,634	1,358,758
1911.....	301,458	1,006,310	1,307,768	1916.....	423,556	1,244,662	1,668,218
1912.....	350,928	970,785	1,321,713	1917.....	462,662	967,340	1,430,002
1913.....	341,338	850,592	1,191,930	1918.....	464,494	498,786	963,280
1914.....	336,662	1,026,617	1,363,279	1919.....	[1]380,000	388,973	[1]768,973

[1] Estimated.

HISTORY.

Pyrites has been known from early times, when deposits in Spain were worked for the copper which the ore contained. The ore assumed no great importance until it was discovered that it could be used instead of sulphur in the manufacture of sulphuric acid.

The first application of pyrites in the making of sulphuric acid is described in an English patent in 1818. However, there was not much development along this line until in 1838, when the Sicilian Government granted a monopoly for the exportation of Sicilian sulphur to the Marseilles firm of Taix & Cie. This firm at once tripled the price of sulphur with the result that the manufacturers of sulphuric acid sought a cheaper raw material. This led to the development of the use of pyrites as the source of sulphur necessary for the manufacture of sulphuric acid, and in 1839 pyrites was first used on a large scale in England for this purpose.

The Sicilian monopoly on sulphur did not last long and some of the producers of sulphuric acid returned to sulphur as the raw material, but during the following years sulphur was, gradually but steadily, replaced by pyrites for the production of sulphuric acid.

The use of iron pyrites as the raw material for sulphuric acid has been followed by the utilization of the gases from the smelting of copper and zinc sulphide ores for this purpose. These gases were

formerly allowed to escape and were a great nuisance to the surrounding country, until legal pressure forced the companies to find a way of utilizing the gases. To-day the copper and zinc smelters constitute one of the important sources of sulphuric acid in this country.

Pyrites at the beginning of the war was recognized as the cheapest raw material for the manufacture of sulphuric acid. However, sulphur, during the war, was used in the manufacture of sulphuric acid on a scale greater than ever before, because of the increased demand for sulphuric acid and the decrease and restriction of the import of Spanish pyrites. It is very likely that sulphur will continue to be used in the manufacture of sulphuric acid in large quantities. In fact, during 1919, domestic sulphur producers contracted to supply many sulphuric-acid manufacturers with their necessary raw material. These sulphur contracts are usually at a price of about 5 cents per unit higher than the existing price of pyrites. In order to secure this business it has been necessary for the sulphur producer, in some cases, to protect the acid manufacturer against a decline in the price of pyrites, taking into consideration the differential in price. When the price of pyrites drops to a figure which differs from the contract price by an amount greater than the agreed differential, the sulphur producer must meet the new price or lose the business.

FOREIGN PRODUCTION.

SPANISH PENINSULA.

Spain and Portugal possess the largest known deposits of pyrites and these two countries produce nearly three-quarters of the world's requirements. Spain is by far the larger producer and Spanish ore has long been considered the most satisfactory pyrites for the manufacture of sulphuric acid. The ore occurs in huge lenses which can be mined very cheaply. Several grades of ore are produced with varying percentages of sulphur and copper. Broadly speaking, the true pyrites ore as mined contains a minimum of 44 per cent sulphur and runs up to 52 per cent, averaging in the neighborhood of 48 per cent sulphur. Copper is found in nearly all of the ore. The sulphur ore ranges from 1½ to 3 per cent copper, averaging about 2 per cent. The outer fringes of the ore bodies contain more copper but less sulphur and true copper ore is found along the extensions of the pyrites lenses. Much of the "copper pyrites" and copper ore is smelted near the mines and is never mixed with the sulphur ore, which contains a maximum of 3 per cent copper.

There are some 20 companies that operate copper and pyrites mines in Spain, but 10 of these produce more than 90 per cent of the total output. The largest companies are owned by British capital. One

French company maintains a fair output and a smaller American producer may be included among the largest 10 producers. There are no German companies, and the small amount of German capital interested in certain of the British companies before the war has now been eliminated.

The Spanish and Portuguese mines are all situated from 40 to 100 miles from the ports, but are well served by rail connections. The larger companies own their own lines. It is stated that the average total cost of reclaiming washed ore from the heaps, screening, freight to port, and loading on the vessel, is only slightly more than $1 per ton. On this class of ore the mine charges and cost of leaching have already been paid by the copper recovered from it. There are several million tons of such ore at the present time in these heaps, the reserves having been added to materially during the war because of the discontinuance of shipments to Germany and but slight reduction in mine outputs. It is not the future policy of the companies to increase largely their reserves of washed ore both on account of the idle capital represented by the ore in these heaps, and because of the better recovery of copper and sulphur under the more recent system of leasing the ore for acid making and retaining control of the cinder. Heap leaching, however, is not likely to be wholly discontinued, since it permits the accumulation of a large reserve of ore against unusually heavy market requirements and permits the continued operation of the mines when shipment is restricted.

OTHER EUROPEAN COUNTRIES.

Norway is the second largest producer of pyrites in Europe. Most of the product has been shipped to Sweden, the Baltic ports, and the north of England. Sweden is the chief market. In the early years of the war there was an important interchange of Norwegian cupreous pyrites for German machinery which was much needed in the Scandinavian countries. But this trade was stopped by the British Government, which agreed to take the entire output of the Norwegian pyrites mines and aid Norway in its importation of requisite supplies and machinery from allied and neutral countries. High mining costs and almost prohibitive freights have practically shut down the Norwegian mines since the war.

France and Germany both produced more than 200,000 tons of pyrites annually, and small amounts are mined in nearly all the other European countries, but in none of these countries is the local production equal to domestic needs, and they must import from Spain, Portugal, or Norway.

CANADA.

There are about six producers of pyrites in southern Canada with a total output of 360,000 tons in 1917. About 80 per cent of the pro-

duction is marketed in the United States. Except for one or two producers of high copper ore, the Canadian miners face the same competition from Spanish pyrites as the American mines.

Production of pyrites in principal countries.

(In long tons.)

[From Mineral Industry.]

Country.	1910	1911	1912	1913	1914	1915
Belgium	210	120	146	264	107	127
Bosnia	562	3,069	6,118	3,191	4,389	(1)
Canada	48,099	73,794	72,776	141,610	200,902	255,397
England	10,229	10,114	10,522	11,428	11,661	10,542
France	246,478	273,512	277,746	306,254	(1)	(1)
Germany	212,302	214,025	238,298	224,798	(1)	(1)
Greece	32,768	35,392	29,296	126,845	127,111	11,922
Hungary	91,004	95,226	102,170	104,945	100,754	(1)
Italy [2]	163,072	162,663	273,202	312,232	330,233	363,488
Japan	77,180	72,712	73,746	112,780	114,013	66,470
Norway	316,916	344,474	461,915	434,252	408,335	505,299
Portugal	307,965	278,308	[3] 591,946	[3] 384,908	[3] 72,245	(1)
Russia	55,096	111,269,	122,032	[4] 127,947	(1)	(1)
Spain [5] Copper mineral	3,180,362	3,232,294	3,311,138	2,232,846	1,478,857	1,456
Spain [5] Iron pyrites	289,536	339,430	414,417	912,268	969,324	789,705
Sweden	25,043	29,621	31,332	33,777	32,787	75,119
United States	223,691	300,158	351,074	341,547	336,681	393,161

Country.	1916	1917	Country.	1916	1917
Belgium	209	80	Japan	89,663	119,431
Bosnia	(1)	(1)	Norway	295,263	(1)
Canada	276,122	360,045	Portugal	(1)	(1)
England	10,488	8,515	Russia	(1)	(1)
France	(1)	(1)	Spain [5] Copper mineral	1,745,893	1,871,299
Germany	(1)	(1)	Spain [5] Iron pyrites	938,610	370,963
Greece	19,623	(1)	Sweden	96,303	140,116
Hungary	(1)	(1)	United States	423,816	462,946
Italy	403,812	492,868			

[1] Reports not available.
[2] Cupriferous in part.
[3] Includes 120,148 tons copper iron pyrites in 1912 and 13,550 tons in 1913.
[4] Estimated.
[5] Taken directly from Estadistica Minera de Espana.

TREATMENT OF PYRITES ORE IN SPAIN.

At a number of the pyrites mines in Spain the ore receives a preminary treatment to recover the copper contained in it. The ore fter being mined is exposed to the weather in prepared heaps about 0 feet high and containing about 100,000 tons of ore. The copper is onverted into a soluble form by atmospheric weathering and is xtracted from the piles of ore by repeated leaching with water. The opper is then precipitated from the water solution by means of iron. bout 90 per cent of the copper contained in the ore is recovered by his method, thus leaving the residual pyrites with a copper content f about 0.3 per cent. This residual ore is known as "washed yrites."

The above method of extraction requires from 6 to 8 years time to ecover 90 per cent of the copper in the pyrites ore. The heaps are ften left two or three years longer before being reclaimed and shipped s sulphur ore. Because of this long period the capital investment

must be large and is locked up in these ore piles for a considerable time. It is estimated that at least three years are required before sufficient copper is recovered to pay for the cost of mining and treating a given pile of ore. In other words it is only possible to turn over the capital investment once in three years.

The pyrites which has been treated by the above process is still suitable for sulphuric-acid making. The washed ore is removed from the piles by steam shovels and is then classified into lump ore and "fines" by screening, before shipment.

IMPORTS INTO THE UNITED STATES.

The imports of pyrites have averaged about 980,000 long tons from 1910 to 1917, inclusive, with a maximum import of 1,244,662 long tons in the calendar year 1916. The importation of pyrites from overseas was necessarily restricted by the Government during 1918. An agreement between the Government, the producers, and the consumers was reached whereby licenses for only 125,000 tons of pyrites imported from overseas would be granted between April 1 and October 1, 1918. The quantity of pyrites actually imported from Spain during this period was 103,160 long tons; in addition during this same period there was imported 160,092 long tons of pyrites, chiefly from Canada. The imports of pyrites from Canada (205,163 long tons) during the fiscal year 1918 were about six times the prewar imports from that country.

Imports of pyrites have steadily furnished about 70 per cent of the domestic consumption with the exception of 1918, when imports were only slightly over 50 per cent of the total quantity of pyrites consumed in the United States.

o llowing table shows the imports of pyrites into the United States by countries and the imports entered for consumption in the United States:

Imports of pyrites into the United States, by countries.

[Fiscal years.]

Imported from—	1909		1910		1911	
	Long tons.	Value.	Long tons.	Value.	Long tons.	Value.
Portugal	71,539	$344,970	96,264	$381,083	117,995	$391,373
Spain	545,448	2,064,276	601,536	2,197,613	742,758	2,619,417
Canada	43,822	152,467	39,500	131,121	28,977	91,[illegible]
All other	100	500	2,202	6,888	3,550	15,963
Total	661,289	2,462,213	729,502	2,626,705	894,281	3,108,069

Imports of pyrites into the United States, by countries—Continued.

(Fiscal years.)

Imported from—	1912		1913		1914	
	Long tons.	Value.	Long tons.	Value.	Long tons.	Value.
Portugal	117,914	$390,969	118,732	$392,296	102,180	$333,978
Spain	840,229	3,388,020	814,534	3,632,392	626,711	2,906,682
Canada	37,103	140,202	31,293	86,948	79,141	312,576
All other	50	250			12,122	32,100
Total	995,296	3,919,450	964,559	4,111,636	820,134	3,585,336

Imported from—	1915		1916		1917	
	Long tons.	Value.	Long tons.	Value.	Long tons.	Value.
Portugal	57,109	$189,710	46,351	$151,445	16,475	$53,426
Spain	667,812	3,531,048	1,207,323	6,489,892	747,866	5,170,447
Canada	99,738	386,491	120,896	473,525	171,268	632,041
All other			471	6,652		
Total	844,659	4,107,249	1,375,041	7,121,614	935,609	5,855,913

Imported from—	1918		1919	
	Long tons.	Value.	Long tons.	Value.
Portugal	2,700	$7,700		
Spain	596,563	3,709,368	172,568	$1,086,507
Canada	205,163	765,429	188,451	820,459
All other	5,629	39,536	9,253	111,451
Total	810,075	4,522,336	370,272	2,018,447

Imports of pyrites into the United States for consumption.

Fiscal year.	Rate of duty.	Quantity.	Value.	Duty collected.	Value per long ton.	Actual and computed ad valorem rate.
		Long tons.				
1909	Free	651,712	$2 54		$3.73	
1910	do	723,277	2 36		3.62	
1911	do	893,457	3 00		3.46	
1912	do	1,004,048	3 45		3.38	
1913	do	966,575	4 07		4.25	
1914	do	846,905	3 79		4.43	
1915	do	875,949	4 49		4.73	
1916	do	1,370,059	7 14		5.19	
1917	do	935,749	5 13		6.25	
1918	do	808,084	4 62		5.57	
1919	do	370,272	2 47		5.45	

TARIFF HISTORY.

Pyrites or sulphuret of iron in its natural state, containing in excess of 25 per cent of sulphur, and sulphur not otherwise provided for, has been free of duty since the passage of the act of 1890. The

following table shows the tariff description of pyrites under the various acts, beginning with the act of 1883:

Rates of duty.

Act of—	Paragraph.	Tariff classification or description.	Rates of duty, specific and ad valorem.
1883.....	144	* * * Sulphur ore, as pyrites, or sulphuret of iron in its natural state, containing not more than 3½ per centum copper, *Provided*, That ore containing more than 2 per centum of copper, shall pay, in addition thereto, 2½ cents per pound for the copper contained therein.	75 cents per ton.
1890.....	133	* * * Sulphur ore, as pyrites, or sulphuret of iron in its natural state, containing not more than 3½ per centum copper, * * * *Provided*, That sulphur ore as pyrites or sulphuret of iron in its natural state, containing in excess of 25 per centum of sulphur, shall be free of duty, except on the copper contained therein * * *.	Do.
	727	* * * sulphur ore, as pyrites, or sulphuret of iron in its natural state, containing in excess of 25 per centum of sulphur (except on the copper contained therein) and sulphur n. o. p. f.	Free.
1894.....	642	* * * sulphur ore, as pyrites, or sulphuret of iron in its natural state, containing in excess of 25 per centum of sulphur * * *.	Free.
1897.....	674	* * * sulphur ore as pyrites, or sulphuret of iron in its natural state, containing in excess of 25 per centum of sulphur * * *.	Do.
1909.....	686	* * * sulphur ore as pyrites, or sulphuret of iron in its natural state, containing in excess of 25 per centum of sulphur * * *.	Do.
1913.....	617	* * * and sulphur ore as pyrites, or sulphuret of iron in its natural state, containing in excess of 25 per centum of sulphur * * *.	Do.

PRICES.

The price of Spanish pyrites increased about 50 per cent during the war, while the price of domestic pyrites increased from three to four times over the prewar prices. The following table shows the wholesale prices of pyrites in the New York market:

Wholesale price of pyrites, spot, New York market, in cents per unit.[1]

[Data from Oil, Paint, and Drug Reporter.]

Year and month.	Spanish lump, unbroken.	Spanish crude, 48–52 per cent, export shipment.	Spanish smalls, washed fines.	Furnace lump ore, washed, 48–52 per cent.	Spanish lump, washed.	Furnace nonarsenic less ⅛ of 1 per cent arsenic.	Domestic concentrates, f. o. b. mill.
1912.							
January	12½–13½	10½–11	10½–11	12½–13	12–13	12½–13½	12½–13
April	12½–13½	10½–11	10½–11	12½–13	12–13	12½–13½	12½–13
July	—@13½	10½–11	10½–11	—@13	—@13	13 –13½	—@13
October	—@13½	10½–11	10½–11	—@13	—@13	13 –13½	—@13
1913.							
January	—@13½	10½–11	10½–11	—@13	—@13	13 –13½	—@13
April	—@13½	10½–11	10½–11	—@13	—@13	13 –13½	—@13
July	—@13½	10½–11	10½–11	—@13	—@13	13 –13½	9 – 9½
October	—@13½	10½–11	10½–11	—@13	—@13	13 –13½	9 – 9½
1914.							
January	—@13½	10½–11	10½–11	—@13	—@13	13 –13½	9 – 9½
April	—@13½	10½–11	10½–11	—@13	—@13	13 –13½	9 – 9½
July	—@13½	10½–11	10½–11	—@13	—@13	13 –13½	9 – 9½
October	—@13½	10½–11	10½–11	—@13	—@13	13 –13½	7 – 7½
1915.							
January	—@13½	10½–11	10½–11	—@13	—@13	13 –13½	7 – 7½
April	—@13½	10½–11	10½–11	—@13	—@13	13 –13½	7 – 7½
July	—@13½	10½–11	10½–11	—@13	—@13	13 –13½	7 – 7½
October	—@13½	10½–11	10½–11	—@13	—@13	13 –13½	7 – 7½

[1] Unit is 1 per cent of sulphur per long ton of ore, or 22.4 pounds.

Wholesale price of pyrites, spot, New York market, in cents per unit—Continued.

Kinds of grades.	Spanish lump, unbroken.	Spanish crude, 48–52 per cent, export shipment.	Spanish smalls, washed, fines.	Furnace lump ore, washed, 48–52 per cent.	Spanish lump, washed.	Furnace nonarsenic less ⅓ of 1 per cent arsenic.	Domestic concentrates, f. o. b. mill.
1916.							
January	—@16	15 –15½	15 –15½	—@15½	—@15½	16@—	11 –12
April	—@16	15 –15½	15 –15½	—@15½	—@15½	16@—	11 –12
July	—@16	15 –15½	15 –15½	—@15½	—@15½	16@—	11 –12
October	—@16	16 –16½	16 –16½	—@15½	—@15½	16@—	11 –12
1917.							
January	—@16	16 –16½	16 –16½	—@15½	—@15½	16@—	11 –12
April	—@16	16 –16½	16 –16½	—@15½	—@15½	16@—	11 –12
July	—@16	16 –16½	16 –16½	—@15½	—@15½	16@—	11 –12
October	—@16	16@—	16@—	16 –16½	16 –16½	16 –16½	11 –12
1918.							
January	16 –16½	16@—	16 –16½	16 –16½	16 –16½	16 –16½	25 –30
April	17 –17½	17@—	17@—	17 –17½	17 –17½	17 –17½	(1)
July	17 –17½	17@—	17@—	17 –17½	17 –17½	17 –17½	28 –30
October	17 –17½	17@—	17@—	17 –17½	17 –17½	17 –17½	30 –33
1919.							
January	17 –17½	17@—	17@—	17 –17½	17 –17½	17 –17½	27 –28
April	17 –17½	17@—	17@—	17 –17½	17 –17½	17 –17½	(1)
July	.....	18½–19	18½–19	19@	19@	19@	(1)
October	.....	16½@	16½@	16½–17	16½–17	16½–17	(1)
1920.							
January	.....	16½@	16½@	16½–17	16½–17	16½–17	(1)
April	.....	.....	.....	.....	.....	.....	.....
July	.....	18½@—	18½@—	18@—	18@—	18½@—	(1)

[1] Nominal.

The manufacture of sulphuric acid, especially the grades of higher strength and purity.

The bleaching of silk and straw.

Disinfection purposes.

Preservation of beverages and food, especially dried fruits.

Manufacture of sodium sulphite and bisulphite.

In metallurgical flotation processes.

4. Vulcanization of rubber.

5. The manufacture of matches.

6. Old-fashioned gunpowder. Sulphur, however, is not used as an ingredient of the modern smokeless powder.

7. Manufacture of certain varieties of cements.

8. Manufacture of carbon disulphide.

9. Manufacture of sulphur chlorides.

10. In the dye industry.

11. Manufacture of sodium thiosulphate, commonly known as "hypo" in the hotographic trade.

12. Vulcanization of corn and linseed oils.

The increased use of sulphur in the manufacture of sulphuric acid during the war because of the inability of imported and domestic pyrites to meet the increased demand is clearly shown by the following table which gives the consumption of pyrites and sulphur by those fertilizer manufacturers who produce their own sulphuric acid. The figures indicate a 60 per cent increase in 1918 over 1917 in the quantity of sulphur consumed by these fertilizer manufacturers. The increase is even more striking when it is remembered that, prior to the war, very little sulphur was used in the manufacture of sulphuric acid, especially of that grade used by the fertilizer manufacturer.

Sulphur and pyrites used by fertilizer manufacturers.[1]

Material.	1917	1918, January to June, inclusive.
	Long tons.	*Long tons.*
Pyrites	522,604	217,[illegible]
Sulphur	93,354	79,[illegible]

[1] From U. S. Department of Agriculture, Bulletin No. 798, A Survey of the Fertilizer Industry.

The War Industries Board[1] estimated that the 1918 production of sulphuric acid was distributed according to the raw material used as follows:

[1] Lewenberg, H. L.: Prices of Mineral Acids, War Industries Board, Price Bulletin, No. 45, 1919.

Source of sulphur.	Tons of 50° Baumé sulphuric acid produced.
Sulphur	4,270,000
Domestic pyrites	1,150,000
Zinc ore fumes	900,000
Copper ore fumes	800,000
Spanish pyrites	600,000
Canadian pyrites	480,000
Total	8,200,000

The above figures show that twice as much sulphuric acid was produced in the United States in 1918 from sulphur as was produced from domestic and imported pyrites.

HISTORY.

Sulphur has been produced commercially in Sicily for several hundred years past. For many years and up to 1903 about 95 per cent of the world's supply was mined and prepared for sale in that country.

In 1838 a monopoly of the Sicilian export trade in sulphur was placed in the hands of a French company (MM. Taix & Cie., of Marseille), which nearly tripled the price of sulphur. This increase in price forced the manufacturers of sulphuric acid to learn how to use iron pyrites as their source of sulphur. As a result the Sicilian producers lost all of this trade, which they have never been able to regain. Then followed the withdrawal of the French monopoly with the subsequent reestablishment of the old price of about $25 per ton for sulphur.

The next important event in the history of the sulphur industry was the development, in about 1890, of the Chance-Claus process for the recovery of sulphur from the alkali waste of the Le Blanc soda process. Advantage was taken of the possibilities of this process to cause internal competition among the Sicilian producers, with the result that the selling price of brimstone was reduced to about $11 per ton, out of which had to be paid the export tax of $1.95 per ton. This state of affairs continued for some time, until 1896, when the Sicilian laborers were on the verge of starvation and revolution. In this year efforts originating in England resulted in the combination of the British and Sicilian interests with the formation of the Anglo-Sicilian Sulphur Co. This combination received the support of the Italian Government, which reduced the export tax on sulphur to 1 lire (19.3 cents) per ton. There followed an increase in the wages of the laborers, abolishment of child labor, and withdrawal of heavy income taxes. The formation of this company resulted in fair and satisfactory prices to both the consumer and producer and a period of 10 years of peace and prosperity in Sicily.

In 1865 a large underground deposit of sulphur was found in western Louisiana. There followed nearly 30 years of effort on the part of different companies to work successfully this deposit by the ordi-

world's supply, has been reduced to about 50 per cent at the end of 1913. The maximum production of 559,936 long tons of sulphur in Italy was reached in 1905, and has since fallen to as low as 208,499 long tons in 1917. The United States imports of Sicilian sulphur have decreased rapidly since 1903 until in 1913 they were negligible.

In 1915 the United States surpassed the other great sulphur-producing country, Sicily, and now occupies the predominant position in the sulphur industry of the world. Sulphur was used in large quantities in the production of sulphuric acid during the war owing to the large increased demand which could not be supplied by either imported or domestic pyrites. This caused an increase in the domestic production from 1914 to 1918 of more than 800,000 tons. It is expected that sulphur will again displace pyrites to a large extent in the manufacture of sulphuric acid in the United States. During 1919 many sulphuric acid manufacturers contracted with domestic sulphur producers for their supply of raw material.

LARGEST PRODUCERS.

The leading producing countries are the United States, Italy, and Japan in the order given. The industry in each country is discussed individually on succeeding pages:

Production of sulphur in principal countries.[1]

[Long tons, 2,240 pounds.]

[1] Converted from Mineral Industry, 1918.
[2] Crude mineral rock impregnated with sulphur.
[3] United States production, beginning with 1909, taken directly from Mineral Resources, U. S. Geological Survey, as sulphur shipped from mines.
[4] Not available.

United States.—Prior to the successful development, in 1903, of the Louisiana sulphur deposit, the sulphur production of the United States was less than one-half of 1 per cent of the consumption. In the following year, 1904, enough sulphur was produced to supply the entire domestic consumption. The output increased rapidly until in 1915 the United States obtained a decided lead over Sicily in the production of sulphur.

The two States of Louisiana and Texas produce about 99 per cent of the entire output of sulphur in this country. The remainder is produced in Nevada and Wyoming for local consumption. The production of sulphur in 1918 was about 1,350,000 long tons. The 1919 marketed production has been estimated at 900,000 long tons.

The principal producers of sulphur are the Union Sulphur Co., at Sulphur, Calcasieu Parish, La.; the Freeport Sulphur Co., near Freeport, Brazoria County, Tex.; and the Texas Gulf Sulphur Co., at Gulf, Matagorda County, Tex.

Sulphur produced and shipped in the United States, 1909–1918.

[From Preliminary Report on the Mineral Resources of the United States in 1918, United States Geological Survey.]

Year.	Mined.	Shipped.		Year.	Mined.	Shipped.	
	Quantity (long tons).	Quantity (long tons).	Approximate value.		Quantity (long tons).	Quantity (long tons).	Approximate value.
1909.....	273,963	258,283	$4,783,000	1914.....	417,690	341,985	$6,214,000
1910.....	247,060	250,919	4,522,000	1915.....	520,582	293,803	3,955,000
1911.....	205,066	253,795	4,573,000	1916.....	649,683	766,835	12,217,000
1912.....	787,735	305,390	5,289,000	1917.....	1,134,412	1,120,378	23,987,000
1913.....	491,080	319,333	5,614,000	1918.....	1,353,525	1,266,709	27,868,000

Italy.—This country, prior to the successful development of the sulphur deposits in the United States, was the world's leading sulphur producer. The competition from sulphur producers of the United States has had a far-reaching effect on the sulphur industry of Italy. The production of crude sulphur-bearing mineral in Italy declined from about 560,000 long tons in 1905 to 208,499 long tons in 1917. Even in the face of an active demand for sulphur in England, France, Australia, Russia, and Sweden during the war the production of sulphur in Italy still continued to decline because of the high cost of fuel and explosives. In 1919 Italy ranked second in the world's production of sulphur. The figures are given on page 230, but are not directly comparable with the production in the United States and other countries, because they represent rock impregnated with sulphur, while the production of the United States is for practically pure sulphur.

The exports of sulphur from Italy are shown in the following table:

Exports of sulphur from Italy.

[From Movimento Commerciale del Regno D'Italia.]

Country.	1910		1911		1912	
	Long tons.	Value.	Long tons.	Value.	Long tons.	Value
Austria-Hungary	32,670	$674,671	39,002	$807,106	42,049	[illegible]
France	93,366	1,771,108	116,160	2,218,027	104,539	1,9[illegible]
Germany	33,455	698,127	32,543	684,006	35,052	[illegible]
Great Britain	18,778	390,522	19,899	420,705	19,751	41[illegible]
Sweden	15,742	298,718	23,590	449,419	27,961	53[illegible]
Russia	25,457	495,500	23,114	455,285	25,160	491[illegible]
Belgium	14,080	272,324	11,593	229,133	10,553	21[illegible]
All other	105,521	2,243,246	126,392	2,728,980	105,3[illegible]3	2,29[illegible]
Total	339,069	6,844,216	392,293	7,992,661	370,438	7,542,[illegible]

Country.	1913		1914		1915	
	Long tons.	Value.	Long tons.	Value.	Long tons.	Value
Austria-Hungary	40,334	$841,533	32,052	$690,041	15,906	[illegible]
France	74,834	1,439,070	63,237	1,247,844	97,524	2,109,[illegible]
Germany	38,363	821,285	23,134	501,687	25,9[illegible]1	[illegible]
Great Britain	16,205	345,768	12,786	288,715	36,298	[illegible]
Sweden	19,232	370,216	17,821	353,332	17,707	[illegible]
Russia	24,951	493,2[illegible]0	20,952	425,907	2,747	65,[illegible]
Belgium	13,113	2[illegible]3,621	5,882	120,593	.....	.....
All other	118,754	2,598,365	79,948	1,841,290	93,120	2,[illegible]
Total	345,786	7,173,118	255,812	5,469,409	289,2[illegible]3	6,900,[illegible]

Country.	1916		1917 [1]		1918 [1]	
	Long tons.	Value.	Long tons.	Value.	Long tons.	Value.
Austria-Hungary	.....	.....	.....	.....	.....	.....
France	109,924	$3,498,299	69,028	.....	83,734	.....
Germany	.....	.....	.....	.....	.....	.....
Great Britain	74,615	2,789,724	21,276	.....	59,882	.....
Sweden	21,376	667,499	2,067	.....	.....	.....
Russia	19,[illegible]31	586,007	4,437	.....	.....	.....
Belgium	.....	.....	.....	.....	.....	.....
All other	95,730	3,730,119	19,662	.....	45,524	.....
Total	321,276	11,271,648	116,470	9,080,095	189,140	14,842,[illegible]

[1] Taken from Statistica del Commercio Speciale di Importazione e di Esportazione.

Japan.—The production of sulphur in Japan prior to the war increased slowly but steadily until in 1913 it was 58,541 long tons. The production of sulphur in Japan was greatly stimulated during the war because of the decrease in Italian output and the increased war demand in European countries. This stimulation resulted in doubling the Japanese production, and in 1917 the total output of sulphur in Japan was 116,125 long tons. This increased production of sulphur in Japan is largely accounted for by increased exports to Russia and Australia. It seems improbable that Japan will be able to maintain this increased output of sulphur when normal conditions in ocean

shipping are restored. The ruling price in Japan during 1916 was $35 per ton f. o. b. Yokohama.[2]

The following table gives the exports of sulphur from Japan, beginning with 1913:

Exports of sulphur from Japan.

[From Annual Return of the Foreign Trade of the Empire of Japan.]

Country.	1913		1914		1915	
	Long tons.	Value.	Long tons.	Value.	Long tons.	Value.
British India	1,046	$23,119	943	$17,914	4,699	$88,250
Dutch India	287	5,807	2,603	49,409	614	13,175
Asiatic Russia	14	352	328	5,446	5,277	90,829
United States	22,357	422,294	18,575	366,465	27,078	482,074
Australia	24,010	426,672	23,306	387,019	28,284	433,075
All others	5,685	109,202	4,939	93,939	7,739	132,683
Total	53,399	987,446	50,754	920,192	73,691	1,240,086

Country.	1916		1917		1918	
	Long tons.	Value.	Long tons.	Value.	Long tons.	Value.
British India	3,776	$140,837	10,579	$544,184	8,502	$344,132
Dutch India	1,740	70,823	6,592	314,957	2,309	84,346
Asiatic Russia	27,531	1,358,520	3,636	159,060	2	205
United States	20,704	598,204	1,178	41,142	278	7,753
Australia	17,278	625,575	48,970	1,509,468	35,379	1,050,113
All others	10,352	304,487	13,141	493,371	6,772	292,742
Total	81,381	3,098,446	84,096	3,062,182	53,242	1,779,291

METHODS OF MINING.

Sulphur was first mined in Sicily. The deposits occur at a depth of from 150 to 650 feet, the sulphur being associated with gypsum. The ore which contains at the most 40 per cent of sulphur was, formerly, brought to the surface on the backs of laborers. Later this method was replaced by mechanical hoisting apparatus. The sulphur is then removed from the gangue by melting; part of the sulphur itself is used as fuel. This method recovers only about 60 per cent of the sulphur in the ore. Steam extraction of sulphur has been successfully applied at Romanga, Italy, but this process does not appear to be practicable on a large scale in Sicily, because of the high cost of fuel and to the excessive losses occasioned by the large amounts of gypsum and limestone associated with the sulphur.

The deposits from which sulphur is obtained in the United States are geographically associated with the "Dome formations." The Louisiana deposit, which is a typical one, has an average depth of 125 feet and is about one-half mile in diameter. This deposit has an overburden of about 450 feet, which is mainly quicksand impregnated with hydrogen sulphide waters. It was this overburden that caused the failure of the ordinary mining methods when applied to this deposit.

[2] Commerce Reports, Feb. 28, 1917.

The difficulties were overcome by a radically new process, which was invented by Herman Frasch. In essentials the process consists in introducing superheated water into the sulphur beds; the sulphur is thereby melted and blown to the surface by means of compressed air. This is accomplished by drilling, and sinking concentric pipes into the sulphur bed. The superheated water is introduced through one pipe, compressed air through a second, and the sulphur rises through the third one. The quantity of sulphur obtained from each well varies greatly because of uncertain underground conditions which can not be definitely determined beforehand. Early in the war period certain of the older fields were thought to have been worked out as no more sulphur could be pumped from the wells, but some of the wells were deepened by about 400 feet with the result that they were again as productive as when first operated. The method requires large quantities of hot water. Crude oil is used as fuel, and its local availability and cheapness have largely contributed to the successful operation of the Frasch process. It is apparent that by this method the labor required is relatively small.

The molten sulphur as it comes from the wells is run into large bins where it cools rapidly. These bins often reach a height of 65 feet. In this manner blocks have been formed containing as much as 150,000 tons of sulphur.

When it is desired to ship the sulphur, a temporary track is laid parallel to the long side of the bin. The boards are removed from the sides and the sulphur is blasted down. It is then loaded into gondola cars by means of a large locomotive crane equipped with a grab bucket. The cars of sulphur on reaching the shipping port are emptied into the steamer by means of automatic machinery, which permits the docking, loading, and sailing of a steamer in 12 hours. From a shipping standpoint the mines of the United States are advantageously located. They are situated close to the Gulf ports, and also have direct connections with southern railways.

IMPORTANCE OF SULPHUR IN COASTWISE SHIPPING.

The chief domestic sulphur markets are located in the Atlantic Coast district. This market is constituted in large part by the fertilizer and paper-pulp industries, which are both large users of sulphur either as native sulphur or in the form of pyrites. The development of domestic sulphur deposits in Louisiana and Texas is an important factor in furnishing tonnage for northbound vessels engaged in coastwise shipping. The heavy movement of freight in the coastwise shipping trade is southbound from Atlantic ports to Gulf ports, while the northbound freight from Gulf ports is comparatively light. Sulphur is an article of sufficient tonnage, to offer a possibility of substantially increasing northbound coastwise

Imports of sulphur, by countries—Continued.

Imported from—	1912		1913		1914		1915	
	Long tons.	Value.	Long tons.	Value.	Long tons.	Value.	Long tons.	Value.
Italy	6,175	$120,860	6	$153	732	$19,675	157	[illegible]
United Kingdom	10	238	.....	.....	224	6,217	1	
North America	32	829	98	2,372	12	500	90	[illegible]
Japan	19,279	331,789	18,653	363,081	18,406	328,519	26,117	[illegible]
All other	.....	.....	.....	.....	15	539	.....	.....
Total	25,496	453,716	18,757	365,606	19,389	355,450	26,365	[illegible]

Imported from—	1916		1917		1918		1919	
	Long tons.	Value.	Long tons.	Value.	Long tons.	Value.	Long tons.	Value.
Italy	201	$5,831	.....	.....	.....	.....	.....	.....
United Kingdom	.....	.....	5	$211	.....	.....	6	[illegible]
North America	30	540	13	483	4	$75	67	1,[illegible]
Japan	22,539	372,599	11,791	205,286	278	8,602	2	
Total	22,770	378,970	11,809	205,980	282	8,677	75	[illegible]

Imports for consumption.

SULPHUR OR BRIMSTONE, CRUDE.

Fiscal year.	Rates of duty.	Quantity (long tons).	Value.	Duty collected.	Value per unit of quantity (long tons).	Ave[illegible] and pur[illegible] val[illegible] ton
1909	Free	17,897	$307,207	.....	$17.17	.....
1910	....do	31,233	537,778	.....	17.22	.....
1911	....do	23,380	409,990	.....	17.54	.....
1912	....do	25,545	453,754	.....	17.76	.....
1913	....do	19,257	374,024	.....	19.42	.....
1914	....do	20,236	346,875	.....	17.14	.....
1915	....do	26,302	442,975	.....	17.14	.....
1916	....do	22,539	372,599	.....	16.53	.....
1917	....do	11,819	205,980	.....	17.42	.....
1918	....do	282	8,677	.....	30.77	.....
1919	....do	75	1,832	.....	24.43	.....

SULPHUR, SUBLIMED, OR FLOWERS OF.

1909	$8 per ton	426	$13,035	$3,404	$30.60	[illegible]
1910 [1]	....do	345	9,956	2,759	28.87	27.
1910 [2]	$4 per ton	821	23,914	3,283	29.14	13
1911	....do	969	27,296	3,877	28.16	14
1912	....do	3,921	87,062	15,686	22.20	18
1913	....do	6,104	122,093	24,416	20.00	20
1914 [3]	....do	289	7,801	1,158	26.95	14
1914 [4]	Free	309	8,040	.....	26.01	.....
1915	....do	950	31,202	.....	32.84	.....
1916	....do	200	7,512	.....	37.56	.....
1917	....do	295	13,317	.....	45.14	.....
1918 [5]	.....	.....	.....	.....	.....	.....
1919 [5]	.....	.....	.....	.....	.....	.....

REFINED SULPHUR.

1909	$8 per ton	751	$19,966	$6,005	$26.59	[illegible]
1910 [1]	....do	50	1,355	398	27.26	2
1910 [2]	$4 per ton	916	22,723	3,666	24.79	1
1911	....do	999	24,072	3,997	24.09	1
1912	....do	1,393	35,448	5,570	25.45	1
1913	....do	1,742	41,626	6,969	23.89	1
1914 [3]	....do	147	3,815	587	26.00	1
1914 [4]	Free	1,376	35,819	.....	26.03	....
1915	....do	1,296	36,275	.....	28.00	....
1916	....do	850	26,778	.....	31.50	.....
1917 [5]	....do	.....	.....	.....	.....	.....
1918 [5]	....do	.....	.....	.....	.....	.....
1919	....do	.....	14	.....	.....	.....

[1] July 1 to Aug. 5, 1909.
[2] Aug. 6, 1909, to June 30, 1910.
[3] July 1 to Oct. 3, 1913.
[4] Oct. 4, 1913, to June 30, 1914
[5] Not listed.

Imports for consumption—Continued.

SULPHUR, LAC OR PRECIPITATED.

Fiscal year.	Rate of duty.	Quantity (pounds).	Value.	Duty collected.	Value per unit of quantity (pounds).	Actual and computed ad valorem rate (per cent).
.....	Free.....	114,699	$7,442	.....	$0.065	.....
.....	....do.....	110,886	6,672	.....	.060	.....
.....	....do.....	130,633	8,098	.....	.062	.....
.....	....do.....	150,952	9,670	.....	.064	.....
.....	....do.....	715,876	13,723	.....	.019	.....
.....	....do.....	233,896	13,636	.....	.058	.....
.....	....do.....	208,568	13,187	.....	.063	.....
.....	....do.....	217,997	16,628	.....	.076	.....
.....	....do.....	69,145	7,009	.....	.101	.....
.....	....do.....	84,224	10,797	.....	.128	.....
.....	....do.....	39,548	5,897	.....	.149	.....

EXPORTS.

Exports of sulphur have increased from 45,595 long tons, valued $864,808, in 1910, to 177,548 long tons, valued at $3,595.512, in 17. In 1918 the export of sulphur decreased to 140,525 long tons, lued at $3,842,904, and in 1919 there was a further decrease to 3,891 long tons, valued at $3,731,386. The exports of sulphur ve been chiefly to Canada. The following table shows the exports sulphur by countries since 1909:

Domestic exports of sulphur or brimstone.

[Fiscal years.]

Exported to—	1909		1910		1911	
	Long tons.	Value.	Long tons.	Value.	Long tons.	Value.
nce.....	12,450	$249,000	25,570	$471,475	.....	.....
many.....	4,570	91,400	1,999	38,032	1,355	$26,560
herlands.....	1,650	33,000	1,113	22,854	.....	.....
ada.....	8,125	162,734	15,226	297.557	14,104	267,099
ico and Central America..	120	2,486	10	197	18	377
foundland and Labrador.	.....	.....	1,500	31,000	1,500	26,250
st Indies.....	9	188	168	3,455	263	5,729
other	4,601	91,719	9	238	29	720
Total.....	31,525	630,527	45,595	864,808	17,269	326,735

Exported to—	1912		1913		1914	
	Long tons.	Value.	Long tons.	Value.	Long tons.	Value.
nce.....	18,100	$339,550	38,260	$682,550	48,500	$851,650
many.....	3,790	78,300	8,241	147,407	20,220	406,350
herlands.....	800	16,000	.....	.....	13,100	229,250
ada.....	16,697	313,439	23,720	448,719	18,964	364,909
ico and Central America..	171	3,470	663	15,988	781	16,780
foundland and Labrador.	1,400	27,300	2,500	48,750	4,000	70,000
st Indies.....	309	6,248	413	8,458	297	6,167
other.....	2	42	64	1,438	[1] 4,160	73,618
Total.....	41,269	784,349	73,861	1,353,310	110,022	2,018,724

[1] Includes 4,000 tons to French Africa.

Domestic exports of sulphur or brimstone—Continued.

Exported to—	1915		1916		1917	
	Long tons.	Value.	Long tons.	Value.	Long tons.	Value
France	6,804	$119,072	8,000	$160,000	22,977	$[illegible]
Germany						
Netherlands	6,450	112,875	2	85		
Canada	33,165	602,692	44,552	814,620	69,895	1,31[illegible]
Mexico and Central America	674	19,816	1,426	33,709	6,823	[illegible]
Newfoundland and Labrador					4,002	[illegible]
West Indies	255	7,630	419	10,400	2,935	[illegible]
South America	455	11,231	571	14,742	3,100	[illegible]
Norway and Sweden	480	9,700	12,793	263,852	27,682	[illegible]
All other	108	2,740	697	16,882	40,134	[illegible]
Total	48,391	885,756	68,460	1,314,290	177,548	3,56[illegible]

Exported to—	1918		1919	
	Long tons.	Value.	Long tons.	Value
France	4,938	$103,424	13,929	[illegible]
Canada	90,859	2,169,701	58,708	1,[illegible]
Mexico and Central America	7,924	233,933	4,066	[illegible]
All other	36,804	1,335,846	47,188	1,[illegible]
Total	140,525	3,842,904	123,891	3,[illegible]

PRICES.

The larger part of the sulphur consumed in the United States is sold on a long-time contract basis. The contract price prevailing before the war and until early in 1916 was practically constant at $22 per long ton f. o. b. New York or about $18 per ton f. o. b. mines. Contracts for sulphur usually cover a period of from one to three years.

During the war the contract price on sulphur increased to $22 per long ton f. o. b. mines. In a very few cases where consumers purchased their supply from month to month or in the open market from dealers the price was naturally higher than $22 per ton. Early in the fall of 1917 the fertilizer committee of the Chemical Alliance acting with the consent of the Council of National Defense made informal arrangements for a price on sulphur of $22 per long ton f. o. b. mines. This policy continued until June 7, 1918, when the War Industries Board took more direct control of the sulphur situation. On June 27, 1918, the War Industries Board by resolution, approved by the President on July 2, 1918, assumed control of the production and distribution of all sulphur materials. This control and price of $22 per long ton was in effect until January 1, 1919. Since this time active competition between sulphur producers has caused a decline in the price of sulphur to $18 to $20 f. o. b. New York in December 1919.

The following table on spot quotations of sulphur in the New York rket as recorded by the Oil, Paint, and Drug Reporter while fol- ing the contract price paid for sulphur prior to the war does not e an accurate idea of the contract price paid for the bulk of the phur during the later years of the war.

Sulphur or brimstone (wholesale), per long ton, spot, New York.

[Data from Oil, Paint, and Drug Reporter.]

Year.	January.	April.	July.	October.
.....	$22 @ $22.50	$22 @ $22.50	$22 @ $22.50	$22 @ $22.50
.....	22 @ 22.50	22 @ 22.50	22 @ 22.50	22 @ 22.50
.....	22 @ 22.50	22 @ 22.50	22 @ 22.50	22 @ 22.50
.....	22 @ 22.50	22 @ 22.50	22 @ 22.50	22 @ 22.50
.....	22 @ 22.50	29 @ 30.00	— @ 35.00	— @ 35.00
.....	— @ 35.00	45 @ —	45 @ —	45 @ —
.....	35 @ 45.00	Nominal.	Nominal.	30 @ —
.....	28 @ 35.00	28 @ 35.00	28 @ 35.00	28 @ 32.00

Sulphur, roll, wholesale, in dollars per 100 pounds, spot, New York.

[Data from Oil, Paint, and Drug Reporter.]

Year.	January.	April.	July.	October.
.....	1.85 @ 2.15	1.85 @ 2.15	1.85 @ 2.15	1.85 @ 2.15
.....	1.85 @ 2.15	1.85 @ 2.15	1.85 @ 2.15	1.85 @ 2.15
.....	1.85 @ 2.15	1.85 @ 2.15	1.85 @ 2.15	1.85 @ 2.15
.....	1.85 @ 2.15	1.85 @ 2.15	1.85 @ 2.15	1.85 @ 2.15
.....	1.85 @ 2.15	1.95 @ 2.25	1.95 @ 2.25	1.95 @ 2.25
.....	1.95 @ 2.25	2.20 @ 2.50	3.70 @ 4.15	3.70 @ 4.15
.....	3.70 @ 4.15	.....	.....	3.70 @ —
.....	3.20 @ —	2.70 @ —	2.70 @ —	2.95 @ —

Sulphur, flour, wholesale, in dollars per 100 pounds, spot, New York.

[Data from Oil, Paint, and Drug Reporter.]

Year.	January.	April.	July.	October.
.....	2.00 @ 2.40	2.00 @ 2.40	2.00 @ 2.40	2.00 @ 2.40
.....	2.00 @ 2.40	2.00 @ 2.40	2.00 @ 2.40	2.00 @ 2.40
.....	2.00 @ 2.40	2.00 @ 2.40	2.00 @ 2.40	2.00 @ 2.40
.....	2.00 @ 2.40	2.00 @ 2.40	2.00 @ 2.40	2.00 @ 2.40
.....	2.00 @ 2.40	2.10 @ 2.50	2.10 @ 2.50	2.10 @ 2.50
.....	2.10 @ 2.50	2.35 @ 2.75	3.85 @ 4.40	3.85 @ 4.40
.....	3.85 @ 4.40	3.25 @ —	3.50 @ —	3.85 @ —
.....	3.35 @ —	2.85 @ —	2.85 @ —	3.10 @ —

Sulphur, flowers of, wholesale, in dollars per 100 pounds, spot, New York.

[Data from Oil, Paint, and Drug Reporter.]

Year.	January.	April.	July.	October.
.....	2.20 @ 2.60	2.20 @ 2.60	2.20 @ 2.60	2.20 @ 2.60
.....	2.20 @ 2.60	2.20 @ 2.60	2.20 @ 2.60	2.20 @ 2.60
.....	2.20 @ 2.60	2.20 @ 2.60	2.20 @ 2.60	2.20 @ 2.60
.....	2.20 @ 2.60	2.20 @ 2.60	2.20 @ 2.60	2.20 @ 2.60
.....	2.20 @ 2.60	2.30 @ 2.70	2.30 @ 2.70	2.30 @ 2.70
.....	2.30 @ 2.70	2.55 @ 2.95	4.05 @ 4.60	4.05 @ 4.60
.....	4.05 @ 4.60	4.05 @ —	4.05 @ —	3.95 @ —
.....	3.55 @ —	3.05 @ —	3.05 @ —	3.20 @ —

sulphur in some of the arts, was classified as "sulphur not otherwise provided for," and not as refined under the act of 1890. (G. A. 432, T. D. 10937, of 1891.)

Sulphur ground but subjected to no process of sublimation or distillation was held crude, or sulphur not otherwise provided for, and not refined, under the act of 1894. (G. A. 3742, T. D. 17756, of 1896.) This decision overruled G. A. 1409, T. D. 12813, of 1892, holding sulphur with a residue of 0.3 per cent after calcination dutiable as refined.

But ground or roll sulphur, with less than one-half of 1 per cent of impurities, was held within the provision in paragraph 84 of the act

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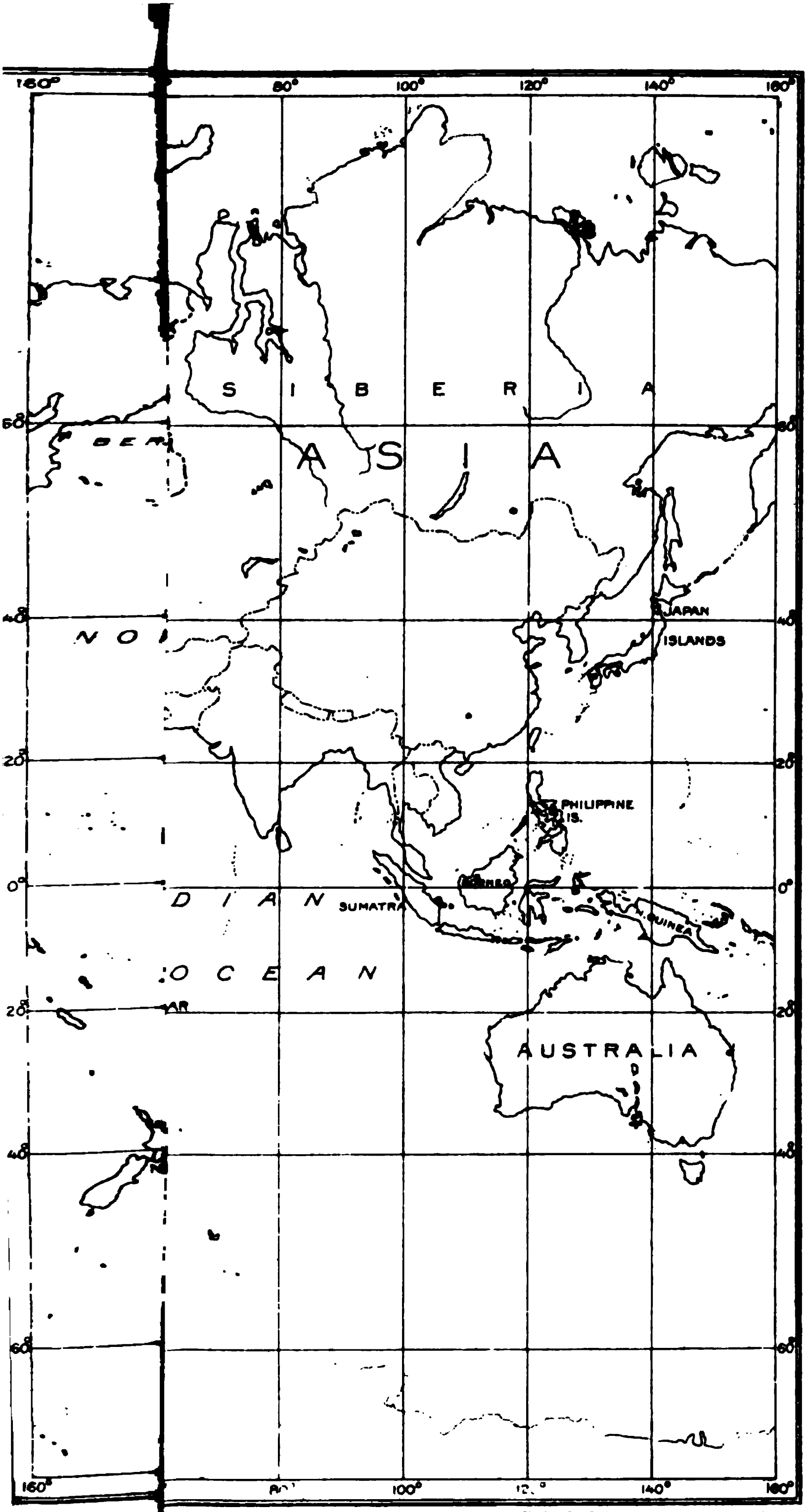
QUICKSILVER



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THE QUICKSILVER INDUSTRY.

DESCRIPTION.

Quicksilver, or mercury, is a silver-white metal, which remains liquid at ordinary temperature. It freezes at minus 38.9° C., boils at 357° C., and is 13.6 times heavier than water. It is marketed in flasks containing 75 pounds each.

Ores.—About 25 minerals containing mercury have been identified, but of these only three are of commercial importance.

Cinnabar is the well-known cochineal-red mercuric sulphide (HgS). When pure, it contains 86.2 per cent of the metal. It is soft (hardness 2 to 2.5) and heavy (specific gravity 8.0 to 8.2). The occurrence is crystalline, massive, or earthy. Its most common associates in ores among other metallic minerals are pyrite (or marcasite), sulphides of antimony or arsenic, sulphur, and, less frequently, sulphides of copper and native gold. Frequent gangue minerals are calcite; quartz, chalcedony or opal; barite; bitumens; and, less often, fluorite. Cinnabar in a more or less pure state is the chief ore of quicksilver and almost the only ore mined in the United States.

Metacinnabarite has the same chemical constitution, when pure, as cinnabar, but is usually massive, gray black in color, and slightly harder.

Native quicksilver.—The native metal, occurring as minute drops or in cavities, and also as an amalgam with silver and other metals, is a frequent associate of the other ores. It is usually considered to be a natural reduction product of cinnabar or metacinnabarite.

USES.

As the only metal that is liquid at ordinary temperatures, quicksilver has unique and special uses in the metallic state. Its comparative chemical inertness together with its weight and mobility, make it valuable for many instruments. It alloys readily with certain other metals forming plastic amalgams. The most important use is as fulminate in blasting caps and other detonators. Both the chlorides of the metal are used in medicine, and surgery, and the oxide by conversion into mercuric chloride by the salt in sea water provides the active poison in antifouling paint for ships' bottoms.

Nonmilitary uses.—Mercury is employed in making drugs, chemicals, fulminate for blasting caps, red oxide for antifouling paint,

barometers, thermometers, thermostats, gas governors, mercury-vapor lamps, batteries, cosmetics, silvering mirrors, boiler compounds, phthallic acid, vermilion, and dental amalgam. It is also used in preparing raw material by hatters and furriers, and in the amalgamation of gold and silver ores.

Military uses.—Its military uses include fulminates for detonating high explosives and fixed ammunition; for medical use in drugs (calomel, corrosive sublimate), and dental amalgam; antifouling paint for ships' bottoms; storage batteries, barometers, etc.

SUBSTITUTES.

An important factor that will affect the post-war demand for quicksilver is the use of substitutes. Just prior to the war the detonator manufacturers were using substitutes for fulminate of mercury. These substitutes were obtained from Germany and the supply was cut off by the war. Now there are several detonators on the market that are composed of substitutes.[1] The substitutes for fulminate are commercially important, in the opinion of American manufacturers of blasting caps. While substitutes will not replace fulminate entirely (as most of them require fulminate to explode them), they are expected to cut down the consumption of fulminate about 75 per cent.

Prior to the war substitutes for fulminate could be secured from Germany at a price equivalent to about $41 a flask for quicksilver. The American substitutes can not compete with pure fulminate at prices lower than $75 a flask for mercury, and even at $105 a flask many of them are little cheaper.

As to the reliability of the substitutes for fulminate, the most tangible evidence is that the ordnance department of no allied Government permitted their use in caps or detonators for war purposes. The use of substitutes is, therefore, confined to the manufacture of blasting caps for use in mining and excavation and in the making of sporting ammunition. A misfire in either of these commodities is not so vital. In blasting it is possible to use two caps in every important shot, and 100 per cent detonation is practically certain when this is done.

There are comparatively few applications of mercury where a substitute is not possible, although the substitute is generally not so good and frequently not so cheap. Mercury can be done away with in making cosmetics, for which 300 flasks are used annually. A large part of the consumption in drugs and chemicals could be saved by

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[1] Data largely from evidence of Leslie Oliver, of the California Cap. Co., and F. L. Ransome, of the U. S. Geological Survey, before the U. S. Tariff Commission at the San Francisco conference, June 26, 1918. The composition of these substitutes is varied. Lead (or silver) azide is one of the most important. Chlorato-trimercuraldehyde, diazobenzene nitrate, nitrogen sulphide, basic mercuric nitromethane, sodium fulminate, and other compounds are also employed.

liminating certain preparations for which substitutes can be used. lost of the consumption for water-treating compounds and for ver-ilion could be saved if necessary.

COUNTRIES OF LARGEST PRODUCTION.

During 1904 and 1905 the United States led the world in production, ut from 1906 to 1916 Spain was the leading producer, accounting for bout one-third of the total. Italy, Austria, and the United States nade up the major part of the remaining two-thirds. In 1913, the ast year before the war, Spain produced 36,619 flasks of 75 pounds; taly, 29,513; Austria, 24,104; United States, 20,213; Mexico and ther countries, 6,606. On the outbreak of the war Austrian sup-lies were at once commandeered by the Central Powers, and Spanish upplies, controlled mainly in London, were held for allied use. nder war conditions the relative importance of the different coun-ries changed to some extent, as may be seen in the following table:

World's production of quicksilver, 1908–1917, in flasks of 75 pounds.

[From Mineral Resources, 1917, U. S. Geological Survey.]

Country.	1908	1909	1910	1911	1912	1913	1914	1915	1916	1917
	Flasks.	*Flasks.*	*Flasks.*	*Flasks.*	*Flasks.*	*Flasks.*	*Flasks.*	*Flasks.*	*Flasks.*	*Flasks.*
United States	19,752	21,075	20,601	21,256	25,064	20,213	16,548	21,033	29,932	36,159
Austria	[1] 16,814	[1] 17,196	[1] 17,725	[1] 20,694	[1] 22,428	[1] 24,104	[1] 25,000	[2] 25,000	[2] 25,000	[2] 25,000
Hungary	[3] 2,289	[3] 2,098	[3] 2,641	[3] 2,339	[3] 2,494	[3] 2,606	[3] 2,500	[3] 2,500	[3] 2,500	[3] 2,500
Italy	[4] 20,106	[4] 22,668	[4] 26,264	[4] 28,072	[4] 29,406	[4] 29,513	[4] 31,541	[4] 28,954	[5] 32,129	[6] 29,300
Russia	[7] 1,389	[8] 206	[8] 118	.....	.....	.....	.....	[9] 800	[9] 1,100	[9] 500
Spain	[10] 31,382	[10] 40,933	[10] 32,892	[10] 43,912	[10] 36,921	[10] 36,619	[10] 28,000	[10] 35,925	[10] 23,369	[10] 25,133
Mexico and other countries	[2] 5,880	[2] 4,500	[2] 4,500	[2] 4,500	[2] 4,500	[2] 4,000	[2] 4,000	[2] 4,000	[2] 4,000	[2] 4,000
Total	97,612	108,676	104,741	120,773	120,813	117,055	107,589	118,212	118,030	122,592

[1] Statistik des Bergbaues in Österreich, Wien.
[2] Statistics not available; estimate only.
[3] Ungar. statist. Jahrb., Budapest.
[4] Riv. servizio min., Roma.
[5] Min. Jour., London.
[6] Eng. and Min. Jour., Feb. 16, 1918 ("nearly 1,000 tonnes").
[7] Statistics of the mineral industry of Russia. Petrograd.
[8] Metallgesellschaft, Frankfurt am Main.
[9] Statistics not available; estimate based on oral information from Russian special commission to United States in 1917.
[10] Estadística minera de España, Madrid.

DEPOSITS IN THE UNITED STATES.

The quicksilver deposits of the United States are found as fissure fillings, often irregular and linked together to form stock works; in complex fracture zones; along bedding and joint planes; and dis-seminated through the country rock. Ore shoots are extremely irregular. Ore and gangue are found as fissure filling, cementing breccias, or impregnating and replacing the wall rock.

Quicksilver ores are found in many kinds of igneous, sedimentary, and metamorphic rocks of various ages. Deposits often follow lines of regional fissuring. The relation is noticeably frequent between

igneous activity and the deposition of quicksilver ores. A considerable number of deposits have proved to be very superficial, decreasing rapidly in size and value at depth.

It is said that the United States can furnish an adequate supply of quicksilver for years to come, provided prices are maintained. The rich ores, however, are practically exhausted and few mines have large reserves even of low-grade ore. The remarkable outstanding feature of the American quicksilver industry is the extremely low grade of the raw material utilized. Material carrying even less than one-quarter of 1 per cent mercury is successfully treated at certain properties; the average ore mined in the United States contains about 0.5 per cent.

DOMESTIC PRODUCTION.

Quantity.—The domestic production of quicksilver in 1918 was 32,883 flasks of 75 pounds each. This quantity is almost twice the production in 1914. In 1876 the United States produced 75,000 flasks—as much as the total production of all Europe. In 1914 it ranked fourth and its output was only one-sixth of the world production. The United States production in 1905 was 30,534 flasks. It declined fairly steadily until 1914, when only 16,548 flasks were produced. In 1919, 21,348 flasks were produced.

In 1918, 69 per cent of the United States production came from California. Texas and Nevada made up 28 per cent and the remaining 3 per cent was produced in Oregon and Idaho. The largest American producer is the New Idria mine in San Benito County, California, which furnishes about one-third of the entire output of the United States. The Chisos mine in Brewster County, Texas, is credited with the second largest production.

Production of quicksilver in United States, 1902–1919.[1]

[U. S. Geological Survey.]

Year.	California.		Nevada.		Oregon.	
	Flasks.	Value.	Flasks.	Value.	Flasks.	Value.
1902	28,912	$1,251,590				
1903	30,526	1,382,523	65	$2,944		
1904	29,217	1,270,940	17	740		
1905	24,635	892,280			(2)	
1906	20,310	802,245			(2)	
1907	17,431	690,268				
1908	16,964	750,183			[3] 386	[3] $17,...
1909	16,078	730,745	316	14,362	493	2...
1910	17,211	800,484	70	3,256		
1911	18,860	867,749	70	3,221		
1912	20,524	863,034	2,550	107,227		
1913	15,391	627,228	1,645	66,178		
1914	11,303	554,414	2,089	102,465		
1915	14,283	1,225,481	2,327	199,657	(5)	
1916	21,045	2,649,355	2,198	276,706	[6] 383	[6]...
1917	23,938	2,521,151	997	105,004	388	+...
1918	22,664	2,663,020	1,044	122,670	702	8...
1919 [9]	14,941	1,344,690	821	73,890	403	3...

[1] Flasks contain 76½ pounds in 1902, 1903, and 5 months, 1904; 75 pounds since June 1, 1904.
[2] Oregon and Utah combined, 1905–6.
[3] Arizona and Oregon combined, 1908.
[5] Arizona, Texas, and Oregon combined, 1915.
[6] Arizona, Washington, and Oregon combined, 1916.
[9] Estimates; average value $90 per flask.

Production of quicksilver in United States, 1902–1919—Continued.

Year.	Texas.		Utah.		Total.	
	Flasks.	Value.	Flasks.	Value.	Flasks.	Value.
1902	5,319	$220,781			91	$1,481,371
1903	6,029	227,763	14	$634	34	1,613,364
1904	5,336	232,116	745	32,407	15	1,536,203
1905	4,723	171,067	[2] 1,178	[2] 42,504	34	1,105,941
1906	4,761	188,060	[2] 1,012	[2] 39,974	63	1,030,279
1907	3,686	145,966	437	17,304	54	863,538
1908	2,382	105,213			52	872,446
1909	4,188	190,345			75	957,859
1910	3,220	154,413			01	958,153
1911	2,326	107,019			56	977,989
1912	1,900	83,680			64	1,063,941
1913	[4] 2,977	[4] 119,785			43	813,171
1914	[4] 3,156	[4] 154,801			48	811,680
1915	[5] 4,428	[5] 379,493			33	1,804,631
1916	6,206	793,862			32	3,768,139
1917	[7] 10,336	[7] 1,141,247			59	3,806,266
1918	[8] 5,473	[8] 995,577			83	3,883,752
1919[9]	5,183	466,470			48	1,921,220

[2] Oregon and Utah combined.
[4] Arizona and Texas combined, 1913 and 1914.
[5] Arizona Texas, and Oregon combined, 1915.
[7] Arizona, Idaho, and Texas combined, 1917.
[8] Idaho (22) and Texas, 1918.
[9] Estimates; average value $90 per flask.

Grade.—The following table, prepared from figures furnished by the United States Geological Survey, clearly shows the general decline in metal content of the American ores:

Total ore production from domestic mines.

Year.	Production.	Metal recovered.		Per cent of ore recovered as metal.
		Per ton.	Total.	
	Short tons.	*Pounds.*	*Pounds.*	
1910	123,562	12.5	1,545,075	0.625
1911	138,525	11.5	1,594,200	.575
1912	155,693	12.1	1,879,300	.604
1913	136,278	11.1	1,515,975	.556
1914	122,998	10.1	1,241,100	.505
1915	158,817	9.9	1,577,475	.497
1916	249,732	9.0	2,244,900	.449
1917 [1]	280,484	9.6	2,692,646	.483
1918 [1]	314,963	7.5	2,352,675	.37

[1] Figures do not include tonnage of dump material treated or metal recovered from this source.

ORGANIZATION AND CAPITALIZATION.

About one-third of the domestic production is made by the New Idria Quicksilver Mining Co., capitalized at $500,000. The remainder comes from a large number of companies, many of which operate on a small scale.

PROCESSES OF EXTRACTION.

Furnace treatment, without previous concentration, has always been the common method for recovering mercury from its ore. The

two essential features of this process are calcining (volatilization of the metal by heating) and condensation. Few other processes that promise success have been developed. Preliminary wet gravity concentration has been tried, and under some circumstances has met with qualified success. As a rule, however, it has not equaled the results of efficient furnace treatment either in the matter of recovery or of low costs. Its only attractive fields are in the treatment of dump material, or, at established mines, for gaining temporary increase in capacity. Concentration by flotation has also been attempted, but is still in the experimental stage. Leaching with alkaline sulphides is a possibility, but is not practiced at any quicksilver mine.

Furnace methods.—The most important advance in quicksilver reduction in the United States was the development of the Scott furnace in 1875. This is a shaft type of furnace with a fire box at the bottom. The ore travels from top to bottom on tiles or shelves, which are set at an angle and staggered. About 24 hours are allowed for the ore to pass through the furnace.

The installation cost of a Scott furnace plant is high, being generally estimated at approximately $1,000 per ton-day. More modern condenser construction permits the reduction of this estimate to $750 per ton of daily capacity No device has yet proved so generally efficient in operation. Severe tests have shown that with careful supervision extractions of over 90 per cent can be obtained with this type of furnace, and this from ore carrying only 5 or 6 pounds of metal per ton. Average practice (1918) in California probably does not recover over 75 per cent.

Encouraged by favorable results achieved by producer-gas fuel, an Austrian plant (Idria) has erected a new Kroupa furnace (patented) which has proved a distinct step toward the bettering of quicksilver metallurgy. The fundamental idea of this furnace construction is to drive off the mercury from the ore between highly heated walls. This type of furnace has vertical parallel shafts separated by walls built of refractory masonry, which contain the heating flues.

Rotary furnaces,[2] which have lately been built at one or two plants, give thorough satisfaction, and for certain types of ore may even displace the standard Scott furnace. Cast-iron retorts of round or D-shaped section have a limited use at small high-grade properties or for the treatment of residues. In addition to these, many other furnaces, notably of the Herreshoff type, have been tried.

Condensation.—The object of condensers is to cool the furnace gases sufficiently to allow the vaporized mercury to condense and the

[2] Cf. Rotary cement kilns.

iquid metal to collect. Condensers are built of brick, stone, cast ron, glass, wood, concrete, or hollow tile. Sometimes the walls are nade hollow and are cooled by water or air. Direct water sprays are)pen to the objection that they carry away floured (very finely livided) mercury. The chief requirements of condenser material are :hat it should have good radiation and neither absorb a large amount)f quicksilver nor be attacked by the furnace vapors. Wood has ately proved satisfactory.

The condensers are arranged in series. The first condenser collects ittle quicksilver and is mainly a dust catcher. The products of the 'ollowing condensers contain less ore dust and show varying amounts)f mercury and water. "Mercurial soot" is an undesirable, but with nost ores, an inevitable product of the condensation system. It is usually mixed with wood ashes or lye to brighten the surfaces of the ittle metal globules and then worked by hand or machinery to make these tiny globules run together so that they can be collected. The residue always contains quicksilver and is generally charged back to the furnace. It is the general theory among producers that there is considerable room for improvement in quicksilver metallurgy along the lines of condensing practice.

Losses in furnace work.—(1) Absorption of mercury by the brick-work of the furnace and condensers is less difficult to estimate and is not considered an ultimate loss, as the mercury so absorbed is largely recovered when the plant is dismantled. It is an important factor in a new plant since, by tying up a considerable amount of metal, it has the effect of increasing the capital investment required at the commencement of operations. In periods of abnormal prices furnaces have frequently been dismantled to recover this mercury.

(2) Fume loss (metal lost up the stack) has generally been considered most serious, but has recently been proved in California to be negligible.

(3) Water losses, chiefly as floured mercury (in suspension) in the water leaving the condensers, is another quantity difficult to measure and subject to considerable variation, dependent upon the care used in operation and, more particularly, in cleaning up. The amount of mercury dissolved by the acid vapors and carried off in solution in the water is very small.

(4) The amount of cinnabar or metallic mercury left in the calcined ore is negligible in good furnace work.

(5) Plant leaks may cause loss of fume if care is not taken to maintain an indraft.

DOMESTIC CONSUMPTION.

Domestic production and consumption of quicksilver.

Calendar year.	Domestic production.[1]	Imports for consumption.[2]	Exports		Domestic consumption (calculated).
			Domestic.[2]	Benefit of drawback.[3]	
	Pounds.	*Pounds.*	*Pounds.*	*Pounds.*	*Pounds.*
1910	1,545,075	667	[4] 144,237	.....	1,401,505
1911	1,594,200	471,944	21,841	.....	2,044,303
1912	1,879,800	82,706	23,283	.....	1,939,223
1913	1,515,975	171,653	85,521	.....	1,602,107
1914	1,241,100	614,869	108,426	.....	1,747,543
1915	1,577,475	421,884	252,852	606	[5] 1,745,901
1916	2,244,900	424,396	666,047	37,333	[5] 1,965,916
1917	2,711,925	390,494	808,336	42,267	[5] 2,250,816
1918	2,466,225	503,053	232,346	8,178	[5] 2,728,754
1919	1,601,100	797,613	683,026	[6] 9,525	1,706,162

[1] From Mineral Resources, U. S. Geological Survey.
[2] From Commerce and Navigation, Department of Commerce.
[3] Fiscal year ending June 30.
[4] Abnormal exports to Canada in 1910.
[5] Approximate (involves use of fiscal year exports with benefit of drawback and calendar year figures of production plus imports).
[6] Estimated from value at $90 per flask.

In normal times about one-third of the domestic output is required for blasting caps. There is a decreasing consumption in amalgamating gold and silver ores. This is attributable to the increased adaptation of cyanide and flotation processes to precious metal ores and to considerable curtailment of quicksilver losses in amalgamation plants. Silver salts are being substituted in silvering mirrors.

In 1917, 26,360 flasks of 75 pounds each were consumed in the United States. This consumption was divided as follows:

	Flasks of 75 pounds.
Drugs and chemicals	8,500
Fulminate	4,850
Vermilion	3,130
Oxide (for antifouling marine paint)	3,000
Electrical apparatus (batteries, electrolyzers, rectifiers, lamps, etc.)	2,700
Felt manufacture (especially hats)	1,700
Gold and silver amalgamating mills	850
Instruments, thermostats, gas governors, automatic sprinklers, etc	630
Miscellaneous, including boiler compounds and cosmetics	1,000
Total	26,360

EXPORTS.

Prior to 1910 the United States made rather large exports of mercury. Little metal was imported, and the domestic production was, therefore, in excess of domestic requirements. This situation was reversed in 1911. Exports dwindled to about 300 flasks, compared with an average of over 4,200 flasks exported annually during the preceding four years. Imports increased in inverse proportion, but exports persisted in spite of the increased importation.

Soon after the outbreak of the European war exports began to ıcrease rapidly. The exports in 1917 (850,603 pounds) were the reatest in the history of the industry. In that year France, Japan, nd Canada received greatly increased supplies from American ources, and for the first time in many years quicksilver was exported) Great Britain. Owing to increased domestic demands following ıe entrance of this country into the war, exports in 1918 were reuced 50 per cent.

Domestic exports of quicksilver.

[1] Includes 307,554 pounds, valued at $284,926, to the United Kingdom; 227,558 pounds, valued at $334,437, Japan; and 92,625 pounds, valued at $99,861, to Hongkong.

QUICKSILVER IN FOREIGN COUNTRIES.[2]

Spain was the leading producer of quicksilver from 1906 to 1916 nd contributed about one-third of the annual supply of the metal. 'he remaining two-thirds has come almost wholly from Italy, Aus-ria, and the United States. But in 1917, out of a world production f probably 122,592 flasks, Spain produced only 20.5 per cent, Italy 3.9 per cent, Austria-Hungary 22.4 per cent, the United States 29.5 er cent, and Mexico and other countries 3.7 per cent.

The Almaden mine in Spain is the most productive quicksilver nine in the world. Recent information obtained by the Bureau of 'oreign and Domestic Commerce throws considerable light on the osition of this property, present and future.

The main ore bodies consist of three parallel layers of quartzite, ilted into a vertical position and separated by beds of slate. The re as mined averages 8 to 9 per cent mercury, and the lowest level 'eached so far shows no impoverishment, although the limits of the nineralized zones are not as clearly defined as in the upper workings. For this reason it is necessary to mine more waste rock with the ore.

The known reserves along the parts of the ore bodies now being worked are sufficient to maintain production at the present rate for

[2] Data largely from article by Dr. Roland Sterner Rainer published in Austria in 1914.

30 years or more. The reserves are all above the bottom level of the mine, and will undoubtedly be increased as development is continued at depth, and new levels are opened up. The ore body terminates to the eastward at a fault, and because of the large reserves in the old portions of the mine, there has been little or no search made for the ore beyond the break. Conditions underground indicate that the ore bodies extend east of the fault, and as this will all be virgin ground from the surface it will increase the reserves enormously. Development in this direction will not be expensive.

The mining and smelting methods employed at Almaden are inefficient. The miners work on the basis of 4½ hours each day for 5 days per month, because of the fear of mercury poisoning, and in order that the men may earn a living wage, the hour rate is high, and a bonus is given for production over a stated minimum. The rate per hour paid underground labor is fully as high as that paid in the United States (in 1918 over 70 cents per hour). The rate to other classes of labor is low. The treatment cost per ton of ore is practically ten times that in the United States and Italy. A change has been made recently in the administration of the property, a commission having been appointed by the Spanish Government to take over the operation of the mine. Unlimited credits are provided for the new buildings and installations for improvement of plant, the commission receiving as compensation for their work a certain percentage of the savings realized in the regular operating expenses over the average for previous five-year periods. The equipment costs are not to be included under operating expense, and unless construction costs are kept at the minimum compatible with efficient operation, the net decrease in production costs may be small. The arrangement promises well, however, and if the actual work of installation is placed in competent hands, the present wasteful practices will be discontinued, with a consequent reduction in the cost of mercury produced. The program includes electric haulage and tramming, better mine ventilation, and complete modern furnace installations.

Under modern scientific management, it is probable that wet drilling will replace the dry machines used at present; dynamite may be used instead of powder, while overhead stoping will be eliminated. These improvements would enable the mine to run longer hours per day, without fear of poisoning the miners, and the savings resulting would materially decrease the producti · costs.

Before the war the cost of production at Almaden was never over $15 per flask; in 1918 it was $33. Costs, even in Italy and Austria, are much greater. The improvements mentioned above should cut the cost to well below even the prewar figure, and with the increased production possible under the new régime, Spain's position in the market will be very strong.

Summary of statistics on Almaden mine.

[Bureau Foreign and Domestic Commerce.]

Year.	Cost.		Wages.					Mercury produced.
			Miners.			Laborers.	Furnace men.	
	Per flask.[1]	Per ton ore.	Per diem of 4½ hours.	Per month of 8 days.	Equivalent per diem wage (entire month).			
	Pesetas.[2]	*Pesetas.*	*Pesetas.*	*Pesetas.*	*Pesetas.*	*Pesetas.*	*Pesetas.*	*Metric tons.*
910	59	.....	10.70	85.60	2.85	.....	.....	1,240
911	62	.....	12.00	96.00	3.20	.....	.....	1,240
912	63	.....	12.40	99.20	3.37	.....	.....	1,240
913	75	174.61	9.25	74.00	2.47	.....	.....	1,025
914	75	.....	8.40	67.20	2.24	.....	.....	1,025
915	85	.....	9.80	78.40	2.61	.....	.....	1,025
916	88	.....	.....	.....	.....	.....	.....	[3] 870
917	125	.....	.....	.....	.....	.....	.....	[3] 870
918	165	398.20	16.00	128.00	4.27	2.50	3.50-4.50	716

[1] Spanish flask equals 76.074 pounds avoirdupois.
[2] Peseta equals approximately 20 cents.
[3] Estimated.

Total workmen employed	2,100–2,500
Total metric tons ore mined 1901 to 1916, inclusive	265,800
Total metric tons ore treated 1901 to 1916, inclusive	207,550
Total metric tons mercury produced 1901 to 1916, inclusive	17,926
Percentage mercury recovered per ton ore treated	8.63
Total metric tons ore treated, 1911 to 1916, inclusive	77,900
Total metric tons mercury recovered, 1911 to 1916, inclusive	6,795
Percentage mercury recovered per ton ore, 1911 to 1916, inclusive	8.72
Percentage mercury recovered per ton ore, 1918	8.62

Loss in smelting, 8 per cent mercury content.

The mine is owned by the Spanish Government. Complete cost reports are available for the production since 1750, and production figures are published since 1499.[4] The Spanish Government is bound by contract to sell, through the house of Rothschild in London, the entire quicksilver production of the Almaden mine, with the exception of 500 flasks reserved for the national industries.[5]

The house of Rothschild is bound to sell in London the greatest possible quantity of mercury, which the house takes over f. o. b. reduction plant, at a price of at least £7 a flask. This contract was made in 1912 and is effective for 10 years. It is rumored that at the expiration of the contract Spain will market the product direct.

Italy.—The Monte Amiata (Tuscany) mines are the principal producers. These mines were exploited by Germans, but during the period of Italian neutrality passed to Swiss bankers and later to

[4] Record of Tariff Commission Conference on Quicksilver, pp. 90-93.
[5] According to Mineral Industry, 1918, the increased Spanish consumption necessitates extension to 1,000 flasks.

The Spanish metal was offered in this country whenever dealers could get a better price here than at home. Whenever the price advanced a little in the United States, there were offers of Spanish quicksilver from England. When the American market went down, the offers from England stopped. The limiting price was variable, depending on conditions. No metal was exported to the United States from England when the price was $35 a flask. After the outbreak of the war, considerable metal was imported when the price was $90 in 1915 and 1916, but later every available pound of metal from the Spanish mines was needed in Europe for war purposes.

Foreign quicksilver was strictly competitive with the domestic output before the war. The imports have fluctuated enormously in spite of the fact that exports have been persistent (although frequently small in amount). Imports for the fiscal year 1917 fell to 242,526 pounds, less than one-half those of the years immediately preceding. A large part of these imports came from Mexico, but some metal must have come from England as the Mexican production was insufficient to supply that amount. This was the first year that there was an exchange of metal with the United Kingdom.[a]

Previous to 1911, imports of quicksilver were very small, never exceeding 17,000 pounds in any one calendar year, although in the fiscal year 1909 over 30,000 pounds were imported. Early in 1911 imports increased in marked degree; over 360,000 pounds being imported in the first six months of the year. Most of the metal came from England, but the high prices in New York attracted about 1,000 flasks from Italy. There was a decided falling off in imports in 1912–13, because of the drop in price from $46.54 in 1911 to $39.54 in 1913, with a slack demand.

In the latter part of 1913 and in 1914 the imports exceeded previous records.

The high prices of 1915–16 attracted all the available foreign quicksilver, and in spite of the fact that exports increased to several times prewar figures, the imports increased above the high-water mark of 1914.

The amount of duty collected on imports of quicksilver varied in 7 years from a little less than $60 (1913) to over $60,000 (1918). These imports can not be considered a dependable source of revenue. Because of the extraordinary prices of recent years, the ad valorem duty of 10 per cent fixed by the tariff act of 1913 has resulted in a greatly increased revenue per unit of quantity.

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[a] Over 300,000 pounds were exported to England in 1917.

Imports of quicksilver for consumption—Revenue.

Fiscal year.	Rate of duty.	Quantity (pounds).	Value.	Duty collected.	Value per unit of quantity.	Actual and computed ad valorem rate (per cent).
1907....	7 cents per pound.....	15,282.00	$6,147.00	$1,069.74	$0.402	17.40
1908....	.....do.....	1,323.50	603.51	92.65	.456	15.35
1909....	.....do.....	30,857.00	16,301.00	2,159.99	.528	13.25
1910....	.....do.....	677.00	366.00	47.39	.541	12.95
1911....	.....do.....	361,332.00	191,108.00	25,293.24	.529	13.24
1912....	.....do.....	193,411.00	100,270.50	13,538.77	.524	13.50
1913....	.....do.....	830.00	387.00	58.10	.466	15.01
1914 [1]...	.....do.....	76,035.00	33,548.00	5,364.45	.438	15.99
1914 [2]...	10 per cent.....	367,738.00	159,061.00	15,906.10	.433	10.00
1915....	.....do.....	561,924.00	292,244.00	29,224.40	.520	10.00
1916....	.....do.....	554,792.00	595,007.00	59,500.70	1.072	10.00
1916 [3]...	10 per cent less 20 per cent.....	60.00	50.00	4.00	.833	8.00
1917....	10 per cent.....	241,330.00	237,779.00	23,777.90	985	10.00
1917 [3]...	10 per cent less 20 per cent.....	1,196.00	622.00	49.76	.520	8.00
1918....	10 per cent.....	579,848.00	641,056.00	64,105.60	1.106	10.00
1918 [3]...	10 per cent less 20 per cent.....	58.00	46.00	3.68	.793	8.00
1919....	10 per cent.....	319,024.00	338,595.00	33,859.50	1.061	10.00

[1] July 1 to Oct. 3, 1913, under act of 1909.
[2] Oct. 4, 1913, to June 30, 1914, under act of 1913.
[3] Reciprocity treaty with Cuba, rebating 20 per cent of duty.

FOREIGN TRADE IN MERCURY COMPOUNDS.

The import figures given above do not include the mercury contained in vermilion and mercury salts. The value of these products imported into the United States in 1916 was $106,077 and in 1917 $34,124. The imports for the former year were exceptionally large. There has also been a considerable importation of fulminates—both those suited for miner's use and for other purposes—and some importation of blasting caps and of percussion caps. The total value of these imports in 1917 was about $187,000. These products contain more or less mercury in the form of fulminate, but there is no way of ascertaining the amount of mercury so imported. It is not great compared with the total imports. Before the war, mercury fulminate was made both in this country and in Canada from domestic metal. Comparatively little metal was used in making percussion caps for rifle cartridges. During the war fulminate was made in the United States and Canada from both domestic and imported metal for blasting and rifle caps. A large part of the exports to Canada are used in the making of fulminate.

During a large part of 1918, the Government prohibited the export of quicksilver—even of foreign metal in bond.

PRICES.

For many years before the outbreak of the European war the price of quicksilver rarely exceeded $50 and was generally below $40 a flask. Early in 1916 an extraordinary demand carried the price temporarily to $300 a flask. In 1918 the Government price

was fixed by agreement with producers at $105 (San Francisco). The open market ranged from $5 to $20 a flask higher. After the armistice was signed prices fell at first gradually, and then quite rapidly, to around $73 in March and April, 1919. This was followed by a rise to $92 in the latter part of June.

As most quicksilver mines have their own reduction plants, ores are rarely sold and do not form an important article of transportation or commerce.

The primary domestic market is San Francisco, since California is the largest producing State. Most of the quicksilver sold in San Francisco, however, is handled on commission and is sold again in New York for distribution to consumers. Practically all the imported metal is sold in the latter market. The New York price is usually in the neighborhood of 50 cents a flask higher than the San Francisco price,[10] and has averaged approximately $3 a flask higher than the London quotation. Prices received by producers in individual sales have varied from the market prices as published. The latter are annual averages of generally prevailing quotations. Sales have been influenced by the amount of metal involved; buyers of only one or two flasks must pay more than buyers of carload lots. New York and London prices for several years are given on page 264, together with prices received for the metal by California producers.

The most important factor in the world market for quicksilver is the Spanish metal. This is contracted for by the Rothschilds at a price of not less than $34 a flask. It is such a large proportion of the world supply of quicksilver that London interests can greatly influence the price by regulating the output. The production of other countries, however, is great enough to prevent an actual monopoly.

The price of quicksilver has always been subject to considerable fluctuation. In 1874 it reached $100 a flask, but it fell rapidly to below $40. There was a steady rise in the price from $37 a flask in 1896 to $51 in 1900 (yearly averages). In the next two years the price sagged and broke in 1903 to $41.32. The price continued to fall until in 1905 it was down to $38.50. A gradual rise brought the price to $47.06 in 1910.

The above variations resulted almost entirely from the relation of domestic supply and demand. Practically no metal was imported.

In 1911 the price began to fall under the pressure of competition from London and the decline continued until early in 1914. Just previous to the war (July) American quicksilver producers were receiving only $36 a flask for their product.

Immediately after the outbreak of the war in August, 1914, the American market fluctuated enormously. The expected demand did

[10] Government price in 1918 was 75 cents higher in New York than in San Francisco.

not materialize; prices fell in October to an average of $53, as compared with an average of $80 in August. In 1915 the general price trend was upward. Monthly averages ranged from $51.90 in January to $92.90 in October, with a maximum of $95 in July. In the latter months of 1915 the price of the metal rose steadily and rapidly and this upward turn resulted in the record price of $300 a flask quoted in the last weeks of February, 1916. American markets were bought up late in 1915, but the excessive price caused foreign Governments to cease buying, although they were in great need of the metal.

In order to secure their requirements at a reasonable price, over 3,000 flasks were sold by agents of foreign Governments in the American market during the first quarter of 1916 and 1,700 flasks in the second quarter.[11] This was probably largely Spanish quicksilver. These sales drove the price down from $300 to $80 a flask and at the latter figure the foreign Governments began to buy back the metal slowly. Their buying was done with extreme caution. Offers were made only for quicksilver placed on the market, without showing any keen demand for the metal. By thus using up only the production without actively bidding on futures, the market was kept in control without the inflation that resulted from the less cautious purchases in 1915.

The foreign influence on the American market is well illustrated by the records of imports and exports of quicksilver in 1916. Of the total exports of quicksilver in 1916, only 0.2 per cent was exported in the first quarter while high prices prevailed; 15.2 per cent went out during the second quarter; 38.8 per cent in the third; and 45.8 per cent of all the exports for the year went out in the last quarter. Imports for the year were in opposite ratio—53.3 per cent came in in the first quarter, 30 per cent in the second, 9.4 per cent in the third, and only 7.3 per cent in the last quarter. The following table brings out the effect of high prices on imports, as well as the careful operations of the buyers for the allied Governments:

Effect of prices on imports and exports, 1916.

Periods.	Imports.[a]		Exports.[b]		Price per flask, New York.[d]
	Pounds.	Per cent.	Pounds.	Per cent.[c]	
First quarter	226,038	53.3	1,517	0.2	$242.92
Second quarter	127,385	30.0	100,762	15.2	102.82
Third quarter	39,978	9.4	258,272	38.8	76.68
Fourth quarter	30,935	7.3	304,996	45.8	79.55
Total	424,336	100.0	665,547	100.0	.....

[a] U. S. Department of Commerce, Quarterly Statement, Imports for Consumption.
[b] U. S. Department of Commerce, Monthly Summary of Foreign Commerce of the United States.
[c] Per cent of total imports (exports) for year.
[d] Mineral Industry, 1917.

[11] Dennis, Clifford G. and Bogard, V. H.: Mineral Industry (1916), p. 639

In February, 1917, another sudden rise brought the New York price above $120 a flask, and except for the month of June, when the price fell to $84.34, the average monthly price was always above $100. On account of transportation difficulties, the differential between the New York price and the San Francisco figure continued to be greater than it was in normal times, although during the period of slack demand in June the western market was the higher for a few weeks.

In 1918 the Government contracted with the quicksilver producers to take 40 per cent or more of their production at $105 a flask. The price was not fixed for other consumers, and the outside market was generally considerably above that figure.

The market in 1919 was unsettled, though fairly strong in the summer months. A minimum quotation of $67 was reported, but the average price for the year on the San Francisco market was about $90. There were no unusual features in the first half of 1920, and on July 17 the metal is quoted at $90 to $92 in New York and $85 in San Francisco.

Prices of quicksilver or mercury.

[Mineral Resources, U. S. Geological Survey.]

[Average price per flask of 75 pounds.]

Year.	New York.[1]	Year.	New York.[1]	San Francisco.	London.[2]	United States[3]
1895	$39.58	1907	$41.50	$39.60	$34.18	.....
1896	37.00	1908	44.84	44.17	40.06	$40.42
1897	38.50	1909	46.30	45.45	41.85	40.04
1898	40.70	1910	47.06	46.51	42.82	43.29
1899	43.63	1911	46.54	46.01	40.13	41.65
1900	51.00	1912	42.46	42.05	39.62	38.69
1901	47.00	1913	39.54	40.23	36.29	36.58
1902	48.03	1914	48.31	49.05	37.71	41.00
1903	41.32	1915	87.01	85.80	70.72	74.21
1904	41.00	1916	125.49	125.89	83.42	89.54
1905	38.50	1917	106.30	105.32	108.09	92.70
1906	40.90	1918	[4] 123.47	117.50	.....	.....
		1919	.....	90.00	.....	.....

[1] Engineering and Mining Journal.
[2] Min. Jour. (London). Exchange calculated at $4.8665.
[3] Net prices received by California producers. H. W. Gould, U. S. Tariff Commission conference.
[4] Government supplies on basis of $105, San Francisco.

DOMESTIC COSTS OF PRODUCTION.

The average cost per flask in 1917 in the United States is reported to have been between $60 and $70. During the first half of 1918 the average cost of 6 mines, whose output represents 63 per cent of the total United States production, is given as $61.12 per flask. Five other mines, representing 18 per cent of the total production, are credited with an average of $91.12 per flask. Of these 11, only 4 properties reported profitable operation in 1916.[13] The computed average cost

[13] Record of Quicksilver Conference. 1918 costs are taken partly from a report by the War Industries Board to the Price Fixing Committee (Nov. 16, 1918) and in part from individual statements of producers. 1917 costs are chiefly from general reports on the industry or statements made at the Tariff Commission conference.

of all the quicksilver produced in the United States during this period is between $70 and $75 per flask.

The estimated average cost of producing a flask of 75 pounds of quicksilver in California was $50 for a period of five years preceding the war. The price of metal was only a little over $35 during this period.

Cost figures for the New Idria mine, the largest quicksilver producer in the United States, producing approximately one-third of the total domestic output, were presented to the Tariff Commission at the conference in San Francisco in 1918. The following summary indicates the increase in cost after the beginning of the war.[13]

New Idria Quicksilver Mining Co.—Comparative costs, 1914 and 1917.

Year.	Tons treated.	Flasks produced.	Pounds.[1]	Cost per flask.	Cost per ton of ore.	Price received per flask.
1914	62,578	6,550	7.8	$51.96	$5.44	$41.00
1917	125,445	11,000	6.58	68.66	4.50	92.70

[1] Per ton of ore treated.

Labor is said to amount to about 43 per cent of the total cost of production at New Idria. At the Sulphur Bank mine, a large low-grade steam-shovel operation, the labor cost constituted a smaller percentage of the total. At smaller mines it is greater.

The chief item of cost in the production of quicksilver is the mining of the ore. Mining costs have usually been at least three times the reduction costs. At present the ratio is probably a little higher and likely to increase. Reduction costs have been kept down by increased efficiency. The average cost per ton of ore treated in a Scott furnace (1918) was between 70 and 80 cents. Fuel requirements as low as 0.031 cord of wood per ton of ore have been reported for a Scott furnace, but it is doubtful if so small a consumption is general. Rotary kilns, recently tested at New Idria, have shown a somewhat better fuel economy than the Scott furnace. The lower first cost and generally cheaper operation may result in a slight decrease in reduction costs, but the great need is for a lowering of the mining costs, if the cost per flask is to be reduced. It is doubtful if this is possible, as American mining is already efficient and as cheap as possible under high labor and material cost.

A factor that keeps up the mining cost is the pockety nature of many of the deposits, requiring continual prospecting and the driving of many "dead" drifts through barren ground to connect kidneys of ore. At one mine (Guadalupe, California), at least, prospecting accounts for about 75 per cent of the underground cost.

[13] Per ton of ore treated.

Costs fell a little during 1919. But the decrease was comparatively slight, and was offset to a degree by the necessity of further exploration and development which were neglected during the war period when every effort was concentrated upon maximum output. Depleted reserves resulting from this neglect of development are also a factor, as the richer blocks of exposed ore were treated during the war in order to get the full benefit of the peak prices.

TARIFF HISTORY.

A duty of 10 per cent ad valorem was placed on quicksilver in 1883. In 1894 the duty was increased to 7 cents a pound ($5.25 a flask), and this flat rate was continued in the acts of 1897 and 1909. In 1913 the duty was put back to 10 per cent ad valorem. At the average prices for the year 1913 ($39.54 a flask) the change resulted in a reduction of duty amounting to $1.30 a flask, or, based on actual import statistics and valuation, from 15 per cent ad valorem to 10 per cent.

In the same act the duty on vermilion reds containing quicksilver and on mercurial preparations was fixed at 15 per cent ad valorem.

Rates of duty.

Act of—	Paragraph.	Tariff classification or description.	Rates of duty, specific and ad valorem.
1883.....	211	Quicksilver.....	10 per cent ad valorem.
	649	(Quicksilver flasks or bottles of American production not specifically exempted when returned.)	
1890.....	207	Quicksilver..... The flasks, bottles, or other vessels in which quicksilver is imported shall be subject to the same rate of duty as they would be subjected to if imported empty.	10 cents per pound.
	493	* * * quicksilver flasks or bottles, of either domestic or foreign manufacture, which shall have been actually exported from the United States * * *.	Free.
1894.....	170½	Quicksilver.....	7 cents per pound.
	387	* * * quicksilver flasks or bottles, of either domestic or foreign manufacture, which shall have been actually exported from the United States * * *.	Free.
1897.....	189	Quicksilver..... The flasks, bottles, or other vessels in which quicksilver is imported shall be subject to the same rate of duty as they would be subjected to if imported empty.	7 cents per pound.
	483	* * * quicksilver flasks or bottles, of either domestic or foreign manufacture, which shall have been actually exported from the United States * * *.	Free.
1909.....	189	Quicksilver..... The flasks, bottles, or other vessels in which quicksilver is imported shall be subject to the same rate of duty as they would be subjected to if imported empty.	7 cents per pound.
	500	* * * quicksilver flasks or bottles, * * * of either domestic or foreign manufacture, which shall have been actually exported from the United States * * *.	Free.
1913.....	159	Quicksilver..... The flasks, bottles, or other vessels in which quicksilver is imported shall be subject to the same rate of duty as they would be subjected to if imported empty.	10 per cent ad valorem.
	404	* * * quicksilver flasks or bottles, * * *, of either domestic or foreign manufacture, * * * which shall have been actually exported from the United States * * *.	Free.

FOREIGN DUTIES.

Quicksilver is admitted free of duty in Great Britain, France, Norway, Sweden, Denmark, Austria-Hungary, and Japan.

Canadian imports are dutiable at 7½ per cent (British preferential tariff 5 per cent). A duty of only seven-eighths cent per pound is levied on imports of quicksilver into Italy. It is not specially provided for in Spain and so comes under the blanket clause for metals, providing a duty of seven-eighths cent per pound. China levies an export duty of 2 Hw. taels per 100 catties or approximately 1¾ cents per pound.

COMPETITIVE CONDITIONS.

The cost of producing quicksilver in the United States in 1918 is reported to have averaged between $70 and $75 a flask. Under pre-war conditions the cost at Almaden, Spain, was $16 a flask; in 1918 it was $33 a flask; and the entire output is contracted to the Rothschilds until 1922 at a minimum fixed price of £7 a flask. On expiration of contract Spain will market the metal.

The difference in cost is ascribable directly to the great difference in the grade and extent of the ore deposits. Metallurgical and mining methods in the United States are highly efficient. This is also true of Austria and Italy, but not of Spain. Nevertheless, Spain can produce the metal at costs much lower than those even of the other European countries, and when modern equipment is installed the difference in cost will be still greater. The quicksilver deposits of California are small compared with those of European countries. The average ore mined in the United States contains only 10 pounds of mercury to each ton of ore treated (i. e., a metal content of only 0.5 per cent). The average ore mined at Almaden, Spain, yielded over 7 per cent (1917), in Italy 0.9 per cent, and in Austria 0.65 per cent.

In the world market American producers are at a distinct disadvantage. No metallurgical advances that can conceivably be made can offset the market handicap of their low-grade ore bodies. Even assuming that, by careful management and technical superiority, the American miner cuts down his costs per ton, in the face of higher wage costs, to a figure lower than the European, the handicap of a possible recovery of only 5 to 10 pounds of metal a ton as against 16 to 220 pounds from the same amount of foreign ore is a heavy one.

The decrease in grade of American ore has resulted in a steady reduction in the output of metal per furnace. To offset this reduction some new furnaces have been built; at other properties wet concentration has permitted the treatment of more ore, as the higher grade concentrated product permits a larger yield of metal per furnace. Doubt as to the stability of adequate prices has held up the

investment of the capital necessary to build much additional permanent equipment even during the period of high war prices.

In 1914 most American producers were losing money. After the outbreak of the war most of them made money. Prices two or three times those existing before the war have prevailed. The American industry had, temporarily, practical immunity from foreign competition. Imports continued in substantial amount, but the metal brought in was supplementary to the domestic supply.

Small advances have been made in American metallurgy, which is probably more efficient than that of any of the other producing country. Both Italy and Austria have had efficient reduction methods. A new furnace was installed in Austria in 1914 that has a capacity of 140 tons a day. This is twice as great as any previous foreign furnace and should still further increase the efficiency of the operation and reduce its cost. Reduction methods in Spain have been costly and inefficient, but the high metal content of the ore counteracted the most wasteful methods, and although the cost per ton of ore treated is normally seven times that in Austria, the cost per flask is much less.

The rise in cost of production in the United States did not keep pace with the price increase. It is not possible to estimate the increased cost in foreign countries during the war, but it is doubtful if the increase was as great in any country as in the United States. The following estimates of mercury content in foreign and domestic ores are from statements made at the Tariff Commission conference in San Francisco in 1918:

Country:	Grade of ore (average).[18]
Spain	11 per cent, or 220 pounds a ton.
Austria	1.1 per cent, or 22 pounds a ton.
Italy	1.0 per cent, or 20 pounds a ton.
United States	0.40 per cent, or 8 pounds a ton.

Early war production costs apparently compared approximately as follows: Spain, per flask, $10 to $25; Austria, $15 to $28; Italy, $28 to $35; United States, $60 to $70.

Although the domestic quicksilver business prospered in the war market, its successful conduct under normal market conditions is problematical. High prices have continued since the signing of the armistice, and the costs of production in the European countries have undoubtedly risen above the prewar levels. But it is unlikely that they have at any time approached the American costs. There is every reason to believe that the Spanish mines can furnish the quicksilver requirements of the whole world for many years at a price only slightly above the minimum at which the output was

[18] It will be noted that these percentages are slightly different from the later estimates of the Geological Survey, used elsewhere in this report.

contracted to the Rothschilds ($34 per flask). This corresponds to a price of less than $40 in the New York market, including the existing duty of 10 per cent ad valorem. Before the war the great mine at Almaden worked only about six months each year. The Austrian mines also could supply the world's requirements. Costs in Austria are more difficult to forecast, but it is safe to assume that the Austrian deposits will be able to compete with the Spanish output at the above price.

At a conference of producers, consumers, importers and exporters of quicksilver, held by the United States Tariff Commission in San Francisco, on June 26, 1918, the dominant note was the emphasis laid by producers on the need for price stability in the quicksilver industry. It was the practically unanimous opinion of producers at the conference that if domestic deposits are to continue to meet a substantial proportion of the home demand, a stable price must be assured and the price must be a high one, i. e., about $100 a flask under war-time costs of production.

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TUNGSTEN.

TUNGSTEN.

SUMMARY.

IMPORTANCE OF THE INDUSTRY.

Tungsten is an essential war metal. The use of tungsten steel for machine tools permits five times the output of work per man and machine possible with the old style carbon-steel tool. Since most munitions and military supplies are dependent upon efficient and quick machine-shop work, the importance of tungsten as a war material is apparent. Ninety to ninety-five per cent of the tungsten produced goes into tool steel.

The tungsten industry is pivotal. In Great Britain much attention has been directed toward guaranteeing adequate supplies for future use—not so much for military preparedness as to assure the efficiency of machine shops and metal-working establishments. All metal-manufacturing industries are largely dependent on tungsten.

FOREIGN AND DOMESTIC RESOURCES.

Although tungsten ore is widely distributed over the earth's surface, 80 per cent of the world's production comes from the United States, Burma, China, and Bolivia. Tungsten deposits are characteristically erratic. Three stages can be distinguished in their exploitation: (1) A stage when the ore can be picked up on the surface or gouged from easily mined surface deposits; (2) a second stage in which the easily and cheaply obtained material has been largely exhausted and underground mining is in progress at only a few specially favored properties; and (3) the stage of production from developed underground mines.

The domestic deposits are typically low grade and production is in the second stage. In other countries, notably Bolivia, Burma, and China, there are large deposits in the primary stage. In the course of a few years most of these foreign deposits will have been exhausted to a degree comparable to that prevailing in the United States, but at present most of the American mines are at a distinct disadvantage. Domestic ores are usually less contaminated with harmful impurities than foreign ores, but the recent development of improved treatment methods is minimizing that advantage.

DOMESTIC SUPPLIES.

The United States is one of the largest consumers of tungsten in the world. Although it also ranks as one of the largest single pro-

ducers, the domestic supply must be supplemented by importation. From 1912 to 1917 less than one-half the amount consumed was imported, but since 1917 considerably more than 50 per cent of the domestic requirements of tungsten ore have been met from foreign sources.

The industry is characterized by a great number of small independent producers with only a few well-financed companies, several of whom are affiliated with consuming interests. However, fully 75 per cent of the prewar output was reported by four large companies. the Atolia in California, and the Primos Chemical, Wolf Tongue, and Vasco, in Boulder, Colo. The remaining 25 per cent comes from a large and constantly shifting group of small operators. Of the tonnage reported by the four large companies a portion consists of crude ore taken out by leasers or purchased from small independent operators.

Future Competitive Conditions.

There were operators in the United States during 1918 who produced large tonnages of tungsten ore at a cost of $10 a unit and less.[1] Until recently at least, the Atolia Mining Co. alone could supply one-third of the total domestic output at a price of $10 or less a unit and was competing successfully in the American market with the important foreign producers, even with tungsten on the free list. Its ability to do so in the future, however, is less probable, as the Atolia ore has suffered a decided drop in grade, and a greatly increased output of ore from the new Chinese fields has been entering the New York market at prices of $5 to $8 per unit.

The Boulder County, Colo., district, which formerly supplied over 60 per cent of the domestic production is stripped of easily mined ore and faces high costs and large investments if its production is to be maintained from its narrow veins and erratic ore shoots at anything like the former rate. In California the depletion is not so far advanced, but the exploitation of the large low-grade deposits, upon which must depend the bulk of future production, is delayed by the necessity of heavy capital expenditures. The general sentiment expressed by producers at the two conferences on tungsten held by the Tariff Commission in June, 1918, was that capital hesitated to undertake the financing of tungsten ventures because no stable or adequate price for the product was assured. The fear of a great influx of foreign tungsten has been a deterrent to the investment of the requisite capital in many of the low-grade deposits of the United States.

The metallurgical treatment of tungsten ores is as efficient in the United States as in any other country and far in advance of that in most countries.

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[1] "Unit," standard term, meaning 20 pounds of valuable constituent (or 1 per cent) in 1 ton of total material.

The main dependence of the United States is the low-grade, hough probably extensive, deposits of the Southwest. American nanagement and equipment in other metals have demonstrated uperiority in mining low-grade properties on a large scale. The cost f production should not exceed greatly that of any other country perating deep, low-grade mines. The serious immediate competition s due to the temporary production from surface ore in foreign coun- ries. Although many of the producers can not compete with this oreign production from surface deposits, they can put tungsten on he market in large amounts at a market price of $17 to $20 per unit, f assured of the stability of this price.

Tungsten is an example of an industry in which an ad valorem luty is particularly difficult to administer. The countries of origin f our imports are not market centers and valuation of the com- nodity is, therefore, uncertain. Wide price fluctuations in the ungsten industry also further complicate the situation.

The reduction of foreign ores into ferrotungsten has developed nto an important industry. The ferrotungsten export trade would not be affected by a duty on the ore unless the privilege of bonded melting were revoked.

THE TUNGSTEN INDUSTRY.

Act of 1913, tariff paragraph:

Tungsten-bearing ores of all kinds (par. 633), free.

DESCRIPTION.

Tungsten metal is never found native but occurs in nature only in the form of tungstates of iron, manganese, or calcium. The minerals are most often found in acid rocks (cf. granite or rhyolite), especially in pegmatite dikes. Except in the United States, it is usually accompanied by tin ore in veins or placer deposits resulting from the erosion of lode formations and from the concentration in stream beds of the heavier constituents of country rock.

Wolframite or iron-manganese tungstate, (FeMn) WO_4, is the most common ore of tungsten. It occurs in long, dark-brown to black crystals or short columnar masses, with a dark-brown streak. The hardness is about 5, or a little less than that of steel. It generally contains approximately 76.4 per cent of tungsten trioxide (WO_3), but, as the name is used to include all variation in composition from pure iron tungstate (ferberite) and pure manganese tungstate (huebnerite), the tungsten content varies slightly, as does the specific gravity between the values for the respective components.[2]

Ferberite or iron tungstate, $FeWO_4$, is a dull coal-black mineral sometimes occurring in aggregates of cubic crystals, but more often massive as black sooty material in veins in pegmatite. After exposure to the action of the weather, ferberite is often so impregnated with iron oxide as to appear brown even along a fracture surface. The specific gravity is 7.5 and the hardness 5. Ferberite is the common ore in Boulder County, Colo., but has not been found in commercial quantities in other parts of the world. It is valuable ore in that district, and the pure mineral contains 76.3 per cent tungsten trioxide.

Huebnerite (hübnerite) or manganese tungstate, $MnWO_4$, is a reddish brown mineral of about the same hardness as ferberite. The specific gravity is about 7.2, or a little less than that of the iron mineral. It is found typically in needle-like crystals in quartz. The theoretical content of tungsten trioxide is 76.6 per cent. The appearance of huebnerite, like that of ferberite, is likely to be obscured by the

[2] The following classification suggested by F. L. Hess of the U. S. Geological Survey has been adopted by some writers and deserves wider recognition: Ferberite, iron tungstate with not more than 20 per cent of manganese tungstate; huebnerite, manganese tungstate with not more than 20 per cent of iron tungstate; wolframite, all mixtures iron tungstate and manganese tungstate between the above limits.

action of weathering, and the mineral in surface exposures is generally coated with black oxide of manganese or brown iron oxide.

Scheelite or calcium (lime) tungstate, $CaWO_4$, is a totally different mineral from the wolframite series. The color varies from nearly pure white to yellow or gray, but always light. Scheelite has not the metallic appearance of the wolframite series and most other metallic minerals, but has a stony look more like quartz feldspar or marble. It is best distinguished from gangue minerals by its greater specific gravity (about 6) and it has a greasy luster that is very characteristic, especially on a freshly broken surface. Scheelite is a little softer than the minerals of the wolframite group (hardness about 4.5) but is harder than calcite. Pure scheelite contains 80.6 per cent tungsten trioxide (WO_3), the highest content of all tungsten minerals.

The value of all tungsten ore depends on its contents of tungsten. This is invariably expressed in terms of tungsten trioxide (WO_3) or tungstic acid (as it is generally, though erroneously, called). The ore as mined rarely contains more than a very small WO_3 content and requires to be concentrated before it can be utilized as a commercial product. The standard "ore" is therefore a concentrated product containing approximately 60 per cent tungstic acid. Quotations are given in terms of dollars per unit. The "unit" is 1 per cent in a ton of total material, and represents either 20 pounds or 22.4 pounds of the valuable constituent, depending upon whether the short ton or long ton is referred to.

USES.

In the steel industry.—At least 95 per cent of all the tungsten ores produced at the present time go into the manufacture of tungsten powder, ferrotungsten, and tungsten steel for the making of high-speed tool steels. The addition of tungsten to steel gives it the property of holding its temper at a much higher heat than that at which simple carbon steels, and most other alloy steels, become soft and worthless. This property of red hardness, as it is called, is very important in cutting tools, as it allows speeding up the work to five or six times the cutting speed allowable with simple carbon steel tools. The strength and comparative toughness of tungsten-steel lathe tools, even when very hot, permits taking a very heavy cut or shaving off the work and the chips often leave the tool so hot that they turn blue. The rapid advance in cutting metals and the great increase in efficiency in machine shops in late years is in a large measure due to the development of tungsten tool steel.

A new use for tungsten steel is for aeroplane engine valves and seats. For several years tungsten steel has been a satisfactory material in internal-combustion engine ignition parts.

An important use of tungsten ores, though one that consumes but a negligible amount, is the making of pure tungsten wire for

incandescent lamp filaments. For this purpose tungsten metal is combined with about 2 per cent of thorium oxide. A little tungsten goes into electric contact points for spark coils, etc. (as a substitute for platinum).

Steel containing 2 or 3 per cent of tungsten is in general use for saw blades.

In industries other than steel.—In the electrical industry the use of tungsten is of considerable importance, the metal being superior to platinum for contact points on account of its hardness and having a heat conductivity equal to twice that of platinum. It is employed as a target for roentgen rays in electrophysical work.

The dye industry employs tungsten for fireproofing cloth, and as a mordant for silks the salt has the added feature of serving as a weighting material.

In the ceramic industry tungstic oxide is used for producing yellows in glass and porcelain.

Sodium tungstate decolorizes acetic acid.

In the chemical industry tungsten wire and sheet are finding an increasing application as laboratory utensil material, owing to the resistance of this metal to alkali solutions and to most of the acids.

Many alloys useful to the chemical industry have been made, among the better known metal compounds being the following: Tungsten bronzes are produced by fusing with pure tin. Partinium is an alloy of aluminum and tungsten, used by the French in automobile construction because of its lightness and strength. Siderophite is an alloy containing a large proportion of iron, some nickel, aluminum, and copper, and 4 per cent of tungsten. It resembles silver in appearance, is very ductile, malleable, and is not easily attacked by acids. Minargent is an alloy of copper, nickel, and tungsten. Backford, or Brittania metal, is an alloy of copper, tin, and tungsten. Platinoid consists of 60 per cent copper, 25 per cent zinc, 14 per cent nickel, and 1 to 2 per cent tungsten. It has a high electrical resistance which does not decrease with heat. An alloy of tungsten, aluminum, and copper is used in the manufacture of propeller blades.

SUBSTITUTES.

No satisfactory substitute for tungsten has been found for alloying with steel for high-speed cutting tools. Molybdenum has somewhat similar properties, and although it has been used to some extent, especially in Europe, it has never proved so satisfactory and is now generally used in conjunction with tungsten, replacing only a part of the latter. Molybdenum steels are, in 1920, receiving considerable experimental attention in the British and American automobile industries, but their usefulness is not finally determined. Vanadium and

cobalt are employed as stabilizers of the molybdenum in molybdenum steel, and while it is reported that thousands of test automobiles containing this steel have given satisfactory results under severe commercial uses, there still prevails an uncertain feeling as to the usefulness of the molybdenum alloy.

Zirconium steel was reported as a substitute for tungsten steel in German aeroplane and motor parts during the war, and the use of zirconium has had much attention on this side. Its utility as a steel component, however, has not been established in the American automobile industry, although much experimenting toward this end is in progress.

Stellite, an alloy of cobalt and chromium, is some times used for cutti g tools as a substitute for high-speed steel. The most satisfactory stellite alloy for cutting, however, contains tungsten as a hardening constituent. Molybdenum is also employed in place of the tungsten in this alloy.

Ferrotantalum and ferrouranium are used, particularly in England, as substitutes for ferrotungsten in the manufacture of high-speed tool steel.

The high prices of 1916 stimulated conservation of tungsten and many cutting tools have been made, of late, with an ordinary carbon steel stock, having only a short piece of high-priced tungsten steel welded on the end. This practice results in a marked saving in the metal, and was a factor in breaking the inflated price of tungsten.

Chromium as well as molybdenum has to some extent replaced tungsten in the making of magnet steel.

HISTORY.

The tungsten mineral wolframite was known in the tin mines of Saxony-Bohemia region, and later in Cornwall, long before the element tungsten itself was discovered.

In 1781 the Swedish chemist Scheele discovered a new mineral acid; the stony mineral discovered later was named scheelite in his honor, while the element he discovered was afterwards named tungsten from the two Swedish words "tung," heavy, and "sten," stone. In Great Britain and its Provinces the word "wolfram" has been compelled to do duty for both mineral and metal, but there is now a distinct trend to the better usage of calling the metal tungsten and the mineral wolframite.

In 1785 the D'Elhujar brothers found that wolframite also contained tungsten and established the relation of scheelite to wolframite They also succeeded in obtaining metallic tungsten from the oxide and were probably the first to reduce the metal from its compounds.[3]

[3] From Bulletin 652, Tungsten Minerals and Deposits, U. S. Geological Survey.

The valuable properties imparted to steel by the addition of tungsten were recognized about 1855, and in 1857 a steel maker named Mushet took out the first patent in England for its use. A few years later the manufacture of a 25 per cent alloy was begun in Germany. The early ferrotungsten was made in crucibles on a very small scale and was very impure. The use of tungsten on any large scale in the making of alloy steel was insignificant until the twentieth century. Small amounts of ore were made into chemicals but tungsten and its ores were very unimportant commodities.

The first lot of domestic ore known to have been produced and sold in the United States was in 1900. The price was then about $2 a unit. Since 1901 the growth of the tungsten industry has been fairly rapid. Germany was the chief market for ore and a large part of the world output was shipped there, to be reduced to metal or ferroalloy or exported to other countries.

The history of the mining of tungsten in every country shows a marked similarity. Although the occurrence of tungsten is widespread, the individual deposits are never of large extent. They are usually pockety. The ore comes in lenticular shoots, and masses, in veins, or irregularly distributed along contacts.

When a new district is first discovered a great deal of float ore may often be found. Later the surface ore is gophered out. Up to this stage the tungsten ore is easily and quickly mined, and the production is large and low costs prevail. Then follows the period of searching for ore underground. This is more of a problem, as the geology of tungsten deposits is not well understood. Underground prospecting is difficult. The "leads" are hard to follow, and, almost invariably, a large amount of deadwork needs to be done before a new shoot is found. After drifting along a narrow vein or crosscutting through barren rock, it often happens that even if more ore is discovered its value is insufficient to pay, in addition to the cost of its extraction, the heavy cost of looking for it. This is the period of depression. A temporary excitement or a "boom" like that which swept over Colorado and generally throughout the world in 1916 when the price soared to record heights, may bring about a greater production, but this is mostly obtained from extremely low-grade material and at high cost. Very few, if any, districts have emerged from the stages of unprofitable underground prospecting and development to the establishment of a permanent, profitable producing stage. Tungsten has the reputation of "playing out" at depth. The character of the ore is such as to preclude this possibility and tungsten is no more likely to pinch out vertically than horizontally, but as the depth increases the pockets are harder and more expensive to find.

MINING METHODS.

Placer tungsten may be worked by any of the usual methods for the recovery of gold or tin in placer deposits. Except when associated with tin or gold, tungsten is not known to be mined by dredging, as the deposits are rarely of sufficient extent to warrant the cost of erecting so expensive a device. Hand washing in pans or sluices is the usual procedure, but in large-scale operations, hydraulicking is done.

Lode mining does not differ essentially from the mining of other ores except that tungsten rarely is found in sufficient amounts or in shoots regular enough to permit of systematic extraction. As a rule the valuable material forms a narrow, tight streak in the rock. These streaks are usually only a few inches wide; and as a man can not work for any length of time in a space less than 18 to 24 inches wide, much barren waste must be broken separately to make room. Care must be taken to prevent the mixing of this rock with the ore. This is often difficult, as the tungsten stringers are "frozen" tight to the walls and, although hard, are easily fractured and lost. To further complicate the extraction of tungsten, the country rock and vein formation are usually very hard. It is evident that these conditions require a peculiar type of miner and one who has a personal interest in saving every possible particle of valuable material. This necessity fosters the employment of "leasers" (lessees) or "tributers"—each man, or group of men, working for himself and being paid for the ore he gets out—rather than the usual system of day's pay.

CONCENTRATION OR MILLING.

The tendency of all tungsten minerals to slime, coupled with the necessity of very fine grinding to separate them from the waste rock, complicates their economical recovery in the milling operation. Stamps were formerly in common use for the secondary crushing after the breaker, but these relics of gold milling are producers of slime and material too fine to be recovered effectually by any mechanical process. Stamps have therefore disappeared from most of the mills and have been replaced by several sets of rolls which successively reduce the size of the ore with a minimum of sliming. Only a small proportion of tungsten concentrate is recovered by jigging the coarse sizes. The bulk of the recovery is on the sand and slime tables. The last slime is still run through a "rag plant" (canvas tables) at many mills with an economical saving.

The desideratum of concentration is the production of a concentrate containing 60 per cent or more of tungsten-trioxide, but the production of so high grade a product from the usual ore containing only 2 to 10 per cent WO_3, results in high losses and much waste of tungsten. To increase the extraction, many mills make two grades

of concentrate; a high grade sand concentrate, containing approximately 60 per cent WO_3 and suitable for making ferrotungsten in the electric furnace; and a slime concentrate of lower grade, containing about 20 per cent WO_3, and suitable only for a chemical process.

If any heavy minerals besides tungsten are present in the ore, the enriched product from simple gravity concentration contains these other minerals also and they must be removed, either because they lower the grade too much or because they are actually deleterious to the product. The usual auxiliary process is magnetic separation and the method of its application depends on the character of the material.

Tin, antimony, copper, and bismuth are found in the ores from South America, Burma, and China. In the United States the chief contaminants of the concentrate are sulphides, which can be easily removed by a weak magnet after a light roast. Ferberite and even wolframite are slightly magnetic and can be picked out by a strong magnet, leaving nonmagnetic sulphides and tin as a separate and, frequently, a salable product.

There has been marked progress in the milling of tungsten ores in the last few years, but it is still a by no means easy problem to get a satisfactory recovery of the minerals in a sufficiently high grade product. Extractions of over 80 per cent are reported, but it is doubtful if the average mill recovers 70 per cent of the values, and this on ore that is fairly high grade as compared to ores of other metals. It is not practicable to treat any material with less than . per cent of tungsten oxide, and in most districts ore with less than ! per cent is not worth treating. Ore containing 1 per cent of WO_3 may have a theoretical value of over $20 a ton, but it is seldom profitable to mill it even when it has been mined and on the dump, whereas ores of gold, copper, or lead with a theoretical value of only $2 or less per ton are profitably concentrated. The reason is the high cost of separation in the case of the tungsten ore. A relatively expensive plant is required and the ore must be put through slowly—often rerun—in order to get a fair recovery.

Chemical concentration is even more expensive than the mechanical processes. Its main field is in the separation of foreign ores containing tin and other impurities and in the treatment of low-grade slime concentrate.

REDUCTION OF TUNGSTEN ORE.

When ferrotungsten was first used a large proportion of it was made by reduction in crucibles using the ore and carbon. This process generally yields a powder unless the ferroalloy is very low grade and can be easily fused. In making a 30 per cent alloy the crucible will last about three heats, but in making a 75 per cent product, it is good for only one heat.

The greater part of the American and other ores free from objectionable impurities is reduced to ferroalloy in electric furnaces, using carbon and the necessary fluxing agents. In England nine ferrotungsten producers were operating in 1919, of whom two used the electric furnace and the others the Thermit process. A recent development is the use of ferrosilicon in the Thermit process as a reducing agent for the production of carbon-free ferrotungsten. The procedure differs from the ordinary Goldschmidt Thermit process by the substitution of 85 per cent ferrosilicon for powdered aluminum. High recoveries are obtained, and the product contains about one-tenth of 1 per cent of carbon. Difficulty is encountered in keeping the silicon low. The recoveries on British plants seem to be much better than those reported in the United States. From the 65 per cent tungsten concentrate ordinarily used, British manufacturers recover up to 95 per cent of the tungsten content of their raw material, both in the electric furnace and crucible.

Impure ores can be treated by the wet process which was largely used in Germany before the war. There are several American plants now equipped for treating ores by this method. It is distinctly a chemical method involving fusion with soda ash, leaching out the sodium tungstate thus formed, and precipitating nearly chemically pure tungstic acid (H_2WO_4) by means of calcium chloride and hydrochloric (muriatic) acid. The precipitate is purified by ammonia and nitric acid, dehydrated, and reduced to metal, either in a stream of hydrogen or by heating with carbon in crucibles. Both methods produce tungsten powder. The second process is the commoner for use in steel while the reduction with hydrogen is employed for making extremely pure metal for incandescent lamp filaments. The steel trade in the United States is inclining toward the use of tungsten powder, and away from the ferrotungsten alloy. The disappearance of the clean pure American ores from the market has had much to do with this.

To produce ductile tungsten for lamp filaments the pure powdered metal is consolidated into rods under great pressure in an electric furnace in an atmosphere of hydrogen and at a temperature of about 2,850° C. (below the melting point of tungsten under normal pressure). The bar thus formed is brittle and could not be drawn into wire. It is made ductile by hammering and rolling in a specially constructed machine, at a temperature of about 1,200° C., and still in an atmosphere of hydrogen. After some fifty successive treatments in this machine the bar is reduced to one-sixth its original size and has become sufficiently ductile. The drawing is done at a high temperature in diamond dies. The production of the ordinary filament requires drawing the metal through about 100 dies, which grow successively smaller until the desired diameter is reached.

COUNTRIES OF LARGEST PRODUCTION.

Tungsten ore is widely distributed and is found in all the continents of the world and in a great number of countries; but no single country produces a very great amount and the resources of almost every corner of the globe are drawn on to furnish a supply. Before the war, Burma (and the Shan States) was the largest individual producer, the United States was the next largest, while Portugal was a close third. These three large producers accounted for only a little more than one-half of the production; the remainder was drawn in small amounts from many other countries, especially in Asia. Africa is the only continent that does not make an important contribution to the tungsten supply. Even Africa, however, reports an annual output.

The following table shows the world's production, the United States production, and the percentage of the world's total produced by the United States from 1913 to 1918:

Concentrates 60 per cent WO_3.

Years.	World's production.	United States production.	Per cent produced by United States.
	Short tons.	*Short tons.*	
1913	9,008	1,537	17.06
1914	8,185	990	12.09
1915	11,995	2,352	19.60
1916	23,315	5,923	25.40
1917	28,309	6,144	21.70
1918	40,687	5,068	12.46

World's production [1] of tungsten ore, 1913–1918, by metallogenic provinces and political areas, in short tons (2,000 pounds) of concentrates containing 60 per cent WO_3.

Province and area.	1913	1914	1915	1916	1917	1918
AFRICA.						
South African province:						
Rhodesia	4	.....	.....	2	12	37
Union of South Africa	.....	.....	.....	1	9	19
Total	4	.....	.....	3	21	56
ASIA.						
Chino-Malayan province:						
Burma	1,891	2,605	2,963	4,166	5,018	4,919
China	.....	.....	.....	[3] 120	[2] [3] 1,500	[3] 11,662
Dutch East Indies (Billiton and Singkep)	7	1	7	52	[4] 61	[4] 61
Federated Malay States	[3] 252	[3] 292	[3] 326	578	794	398
French Indo-China (Tonkin)	[3] 101	119	220	183	422	[5] 450
Siam	.....	301	475	584	800	[5] 800
Unfederated Malay States—						
Johore [3]	.....	.....	2	25	2	1
Kedah	32	27	14	19	139	582
Trengganu [3]	94	160	161	303	225	691
Indian province, India (excluding Burma)	.....	.....	.....	47	69	45
Japo-Korean province:						
Chosen (Korea)	.....	.....	74	613	992	[3] 1,102
Japan	272	215	411	770	808	[3] 651
Total	2,649	3,720	4,653	7,460	10,830	21,362

[1] Figures unaccompanied by footnote references are taken from official sources or other authentic publications. In all cases the original quantities have been reduced to their equivalent in concentrates containing 60 per cent WO_3.

[2] Figures partly official and partly estimated by the U. S. Geological Survey.

[3] Exports.

[4] Figures estimated by the Allies when it was proposed to allocate the tungsten ores of the world among themselves.

[5] Figures estimated by the U. S. Geological Survey.

World's production of tungsten ore, 1913–1918, by metallogenic provinces and political areas, in short tons (2,000 pounds) of concentrates containing 60 per cent WO_3—Con.

Province and area.	1913	1914	1915	1916	1917	1918
AUSTRALIA.						
Australian province:						
New South Wales	[3]191	[3]220	[3]93	[3]296	[3]274	[illegible]
Northern Territory [2]	217	159	366	401	427	6[illegible]
Queensland	402	270	468	415	406	2[illegible]
South Australia	.....	.....	.....	1	.....	.....
Tasmania	76	53	106	119	270	4[illegible]
Victoria	1	.....	18	1	25	[illegible]
Western Australia [3]	1	1	.....	4	1	[illegible]
Total	888	703	1,049	1,237	1,403	1,4[illegible]
EUROPE.						
Erzgebirgan province:						
Austria	57	62	[4]75	[4]150	[4]150	[4]15[illegible]
Germany	[3]318	[4]100	[4]150	[4]351	[4]200	[4]2[illegible]
Franco-Cornish province:						
England	204	229	370	441	270	3[illegible]
France	301	[4]200	[4]200	[4]182	[4]182	[4]1[illegible]
Iberian province:						
Italy	.....	.....	.....	9	1	.....
Portugal	1,241	735	1,029	1,563	1,742	[4]1,3[illegible]
Spain	186	149	208	468	491	4[illegible]
Russian province, Russia	.....	.....	.....	36	[2]108	[4]1[illegible]
Scandinavian province, Norway	3	4	.....	1	[4]10	[4]1
Total	2,310	1,479	2,032	3,201	3,154	7[illegible]
NORTH AMERICA.						
American province:						
Alaska	.....	.....	([5])	47	32	[illegible]
United States	1,537	990	2,332	5,876	6,112	5[illegible]
Canadian province, southeastern Canada	.....	.....	.....	.....	.....	[illegible]
Southwestern province, Mexico	.....	.....	.....	13	207	[illegible]
Total	1,537	990	2,332	5,936	6,351	5[illegible]
OCEANIA.						
Oceanic province, New Zealand [3]	248	228	217	298	181	[illegible]
SOUTH AMERICA.						
Brazilian province, Brazil	.....	.....	.....	[illegible]7	.....	.....
Cordilleran province:						
Argentina [3]	679	499	201	963	1,251	[illegible]
Bolivia [3]	339	330	947	3,624	4,646	4,0[illegible]
Chile	.....	.....	10	2	.....	.....
Peru	357	235	455	587	471	2[illegible]
Total	1,375	1,064	1,613	5,183	6,368	5,1[illegible]
Grand total	9,011	8,184	11,896	23,318	28,308	40,6[illegible]

[2] Figures partly official and partly estimated by the U. S. Geological Survey.
[3] Exports.
[4] Figures estimated by the Allies when it was proposed to allocate the tungsten ores of the world among themselves.
[5] Figures estimated by the U. S. Geological Survey.
[6] Less than half a ton.

DOMESTIC PRODUCTION AND RESOURCES.

Colorado was the chief producer of tungsten ore of the United States for 14 years. In 1914 the production of California was greater than that of Colorado. In 1917, and again in 1918, their respective productions were practically equal and their combined output was about 80 per cent of the total output of the country. Nevada is the third largest producing State, but its output is considerably less than that of either of the first two. Arizona is a small but regular producer. South Dakota has been an intermittent producer of wol-

framite, which is found in association with the gold ore of the Black Hills. Tungsten ore has also been produced in New Mexico (wolframite), Utah (scheelite), Idaho (huebnerite), Missouri, and Connecticut, and showings have been reported in other States.

PRODUCTION IN UNITED STATES.

Tungsten-bearing ores (concentrates containing 60 per cent WO_3).

[Figures from Mineral Resources, United States Geological Survey.]

State.	1910		1911		1912	
	Quantity (short tons).	Value.	Quantity (short tons).	Value.	Quantity (short tons).	Value.
Arizona	[1]	[1]	50	$16,559	27	$9,566
California	[1]	[1]	[1]	[1]	[1]	[1]
Colorado	1,221	$535,567	730	234,513	812	297,533
Idaho	.....	.....	[1]	[1]	[1]	[1]
Nevada	.....	.....	[1]	[1]	[1]	[1]
New Mexico	.....	.....	.....	.....	.....	.....
Washington	103	51,768	[1]	[1]	.....	.....
Alaska	.....	.....	.....	.....	.....	.....
Connecticut	.....	.....	.....	.....	.....	.....
Utah	.....	.....	.....	.....	.....	.....
All other	497	245,657	359	156,913	491	195,059
Total	1,821	832,992	1,139	407,985	1,330	502,158

State.	1913		1914		1915	
	Quantity (short tons).	Value.	Quantity (short tons).	Value.	Quantity (short tons).	Value.
Arizona	16	$6,069	15	$6,435	127	$245,360
California	541	226,260	[1]	[1]	962	1,005,467
Colorado	953	428,760	467	182,013	963	2,311,200
Idaho	[1]	[1]	[1]	[1]	32	47,602
Nevada	[1]	[1]	.....	.....	55	130,466
New Mexico	[1]	[1]	[1]	[1]	45	70,934
South Dakota	[1]	[1]	.....	.....	140	181,089
Washington	[1]	[1]	.....	.....	[1]	[1]
Alaska	.....	.....	.....	.....	[1]	[1]
Connecticut	.....	.....	.....	.....	[1]	[1]
Utah	.....	.....	[1]	[1]	[1]	[1]
All other	27	11,029	508	246,552	8	107,882
Total	1,537	672,118	990	435,000	2,332	4,100,000

State.	1916		1917		1918	
	Quantity (short tons).	Value.	Quantity (short tons).	Value.	Quantity (short tons).	Value.
Alaska	47	$69,518	32	$45,000	12	$22,000
Arizona	218	385,292	150	173,700	213	245,240
California	2,171	4,098,999	2,781	3,010,300	1,791	2,620,165
Colorado	2,401	4,666,301	2,707	2,994,000	1,910	2,557,428
Idaho	101	113,470	2	1,933	.....	.....
Nevada	689	2,240,619	143	187,500	885	1,070,100
New Mexico	16	39,227	.....	.....	.....	.....
South Dakota	239	404,775	270	299,644	[2] 201	247,098
Connecticut, Missouri, Montana, Oregon, Utah, and Washington	41	57,216	59	71,085	29	40,105
Total	5,923	12,075,417	6,144	6,783,162	5,041	6,802,136

[1] Included in "All other."

[2] Includes Utah.

Colorado.—Practically all the Colorado output is mined in Boulder County. The tungsten is found in a belt nearly 12 miles long and about 7 miles wide, situated about 25 miles northwest from Denver and centering about Nederland. Prior to 1914 this district produced fully 60 per cent of the tungsten output of the United States, 75 to 80 per cent of which came from shallow workings that are now exhausted.

The dominant ore is ferberite, which is not mined to any extent in any other part of the world. It is typically difficult to mine, as it is usually found in very narrow seams or comparatively small lenses in very hard granite or gneiss. The absence of tinstone, tourmaline, and other common associates of tungsten minerals is noteworthy. The Boulder County ore is exceptionally free from impurities and generally commands a higher price than foreign ores because of its extreme purity. The average grade of the ore in Boulder County is perhaps 5 per cent WO_3,[4] and the dump ore at producing mines will contain about 0.5 per cent. It is significant that the great excitement of 1915–16 failed to open up any important new ore bodies in this district. Practically all the large areas of float ore and the easily mined surface deposits are exhausted, and now the production comes almost wholly from fairly deep workings, which are more expensive to mine. The ore shoots are variable in length and depth. The average thickness of the mineral bearing vein matter is only a few inches.

In 1916 there were 10 concentrating mills operating in the district, but in 1918 fully half of them were shut down. In 1919 tungsten mining ceased in Boulder County, and in the entire country, and two or three properties only were in operation out of a normal producing list of several hundred.

A large proportion of the Colorado producing properties are owned and operated by consumers of tungsten, i. e., steel companies or manufacturers of ferrotungsten and other tungsten products. Mining and development are done almost exclusively under the leasing system, the "leaser" being paid for the ore he extracts (after deducting a royalty). When an unusual amount of prospecting or "dead" work is necessary, the expense is either shared by the company and the lessee or done on "company account."

Tungsten ore has been mined at various other localities in Colorado, notably in the southern section, where huebnerite is the chief ore. The production has never been important, and practically all these mines ceased operations in 1917 or earlier..

California.—California is the largest producer of scheelite in the world. The greatest proved bodies of tungsten ore in the United States, and perhaps in the entire world, are those of the Atolia-Rand

[4] Brief of tungsten producers, conference of the Tariff Commission at Denver.

istrict in San Bernardino County in the southwesterly section of this tate. The Atolia deposit has been worked to a depth of 700 feet, ertical, and the width has in many places exceeded 3 feet of ıngsten bearing material, consisting largely of scheelite and quartz. ike the Colorado ore, the California product is exceptionally free om harmful impurities. Since the adverse prejudice of consumers as been overcome, the California scheelite has commanded a premium ver imported ores and even over the Boulder County concentrate, hich is more difficult to reduce.

The deposits are found along more or less continuous fissures and ıay be broadly classed as contact metamorphic deposits in distinc- on from the stringer lodes of Colorado. The deposits, therefore, re often of much larger extent, although frequently low grade. he same geological formation found at Atolia extends east and west. Vestward, the ore in Kern County is wholly scheelite. Eastward, ıore or less of the wolframite series of tungsten minerals is found long with the lime tungstate. Scheelite is the principal tungsten ıineral so far produced in California, and the wolframite deposits, specially those dominantly of huebnerite, have been generally low rade and pockety. There is no ferberite, but there are two districts ı San Bernardino County where the ore is characteristically olframite.

There are four counties in this State from which tungsten has ome, San Bernardino, Inyo, Kern, and Nevada. By far the largest roduction has been derived from San Bernardino, and the major art of this has come from the Atolia Mining Co., which began pro- ucing in 1908 and maintained active mining until after the war. One f the most interesting developments in the last few years has been ıat in Inyo County, where the ores differ from the more distinctly ode occurrences of other sections, as the scheelite is disseminated ırough metamorphic rock. The ore bodies are much larger than ven the big Atolia deposit, but the average grade of the ore treated ı less than 1 per cent (occasionally as low as 0.5 per cent), whereas he ore of the Atolia Co. runs from 2 to 8 per cent WO_3 in the mill irt and some high grade is obtained by sorting. It is reported in 919, however, that the Atolia ores now in reserve will show a con- iderable decrease in grade.

The production from Kern County and from the balance of the ıtolia district, outside of the Atolia Mining Co., comes largely from mall operators who produce a few tons here and there, partly from odes and partly from placer workings. It appears, however, that here are large bodies of low-grade ore from which economical re- overy could be made if the price were a sufficient inducement.[5] A

[5] W. W. Bradley (representing Fletcher Hamilton, State mineralogist of California), Report of United tates Tariff Commission Conference at San Francisco, p. 57.

small amount of scheelite has been produced in Nevada County, over 300 miles from Atolia.

Nevada.—The only important production so far made by Nevada was in 1916 when 615 tons of 60 per cent concentrate were produced. The most extensive production has come from White Pine County and from Sodaville in Humboldt County. The ore is largely scheelite. During the period of high prices (1915–16) these counties were very active, but nearly all operations were discontinued soon after the spectacular decline in the tungsten market. Extraordinary finds of large bodies of high-grade ore have been reported from time to time in various parts of the State, but a sudden cessation of output is now coincident with the break in price. The evidence submitted at the United States Tariff Commission conference in San Francisco indicates a strong probability of the existence of important bodies of low-grade ore, particularly in Nye and Mineral Counties. In these counties no lode deposits have been exploited, but a very large tonnage of placer material is said to be available. There is a large ore body at Mill City, Humboldt County, that it is believed will eventually furnish a large supply of tungsten at a very low cost. The development of the low-grade deposits of Nevada will require a considerable outlay of capital. The tungsten area can be broadly considered as a continuation of the California formations, which it resembles in many particulars. There is a larger proportion of wolframite, especially huebnerite, but scheelite is the dominant tungsten miner. Many of the deposits also contain sulphide minerals, but a good grade of concentrate can be made, as there are few very objectionable impurities.

Alaska.—Although scheelite had been known to exist in several of the Alaskan placers, the demand was insufficient to encourage its recovery until 1915. The production has never exceeded 50 tons a year and this is mainly a by-product of the gold-dredging operations in the Nome placers. There is a small lode production in the Fairbanks district.

FOREIGN PRODUCTION AND RESOURCES.

Burma.—Burma, including the Shan States, is one of the newest tungsten-producing areas. The first important output was made in 1910.

Production increased rapidly thereafter and by 1912 this area had become the world's largest producer; this position it held until superseded by the United States in 1916.

There are four important districts found in a belt about 56 miles long and 7 miles wide and at least 50 producing mines. The ore is wolframite and the output has come largely from placers and surface

loat. Ground sluicing is the common method of recovering the valuble mineral, but hydraulicking is employed at some of the larger roperties and lode mining is on the increase. The most important ode district is Tavoy, where the veins are found in a schist of sedinentary origin, capping granite. No lowering in grade has been eported as the veins extend downward into the granite; but the vidth is generally less—a vein 2.5 feet wide in the schist, narrowing lown to 2 feet or less in the granite. All the tungsten deposits contain tin, which is frequently an important by-product. Other harmful impurities, such as galena, pyrite, columbite, and molybdenite, are also invariably present.

The Burmese tungsten industry passed from German to British control in 1915. All shipments had formerly been made to Hamburg and the assays made by the German Government for the duty assessment (2.5 per cent ad valorem)[6] were accepted by buyers and sellers as the basis of settlement. The outbreak of the war resulted in a temporary derangement of the tungsten industry in this area, and in spite of the urgent need of the British Government for tungsten, Burma did not respond rapidly at first. Prospecting is hindered by heavy rainfall in the summer months, amounting to 200 inches from May to November. Lack of transportation and title difficulties were serious handicaps in addition to a shortage of labor. The British Government took an active part in the mining and marketing of Burmese tungsten in the fall of 1915. The Government imported coolies and managers to work the mines and claims that were lying practically idle, and built roads and bridges. Under this stimulus, production increased 50 per cent in 1915 and the output in 1917 was almost three times as great as in 1914. There was some protest from mine owners because of the fixing of the maximum price at 55s. ($13.365) per long ton unit (22.4 pounds) of WO_3 when prices in neutral countries were several times as much. That this price did not allow sufficient profit is evidenced by the fact that it was later (1917) increased to 60s. ($14.50) a long ton unit. (These quotations were for 65 per cent concentrate, f. o. b. Liverpool.)

The labor in Burma is almost wholly Chinese under the direction of white superintendents. Mining and development are usually under contract. In spite of the large increase in the output, the methods of mining are still primitive. Most of the crushing is done by hand hammers and the ore is concentrated in cradles (by hand). There is seldom any attempt to remove tin at the mine. Some of the ore is treated with magnetic separators to take out the tin before shipping

[6] Mineral Industry, XXIII (1914), p. 754. Probably a countervaling tariff, as tungsten ore is normally admitted free into Germany under the act of 1906.

to England, but usually the mixed product is shipped. One or more magnetic separators have been installed at Rangoon.

China.—A new and important production comes from southern China in the Provinces of Hunan, Kwantung, Kiangsi, and Chili. It is this Chinese field, with its abundance of easily recovered high-grade float ore, that now offers the world's cheap supply of tungsten (1920). As has been the case for years in the antimony trade, China has now taking a dominant position in the world's tungsten market, by reason of its superior resources of the metal and extremely low-priced labor with which to produce it. Prior to 1917 China was not known as an important producer of tungsten ore; in 1918, Chinese maritime customs figures showed a total export of 5,183 short tons. During the first 10 months of 1919, 4,740 short tons of ore, valued at $3,269,123, and of probable WO_3 content 65 per cent or more, were imported into the United States from China.

Mining methods in the Chinese fields are peculiar in that the deposits are largely owned by communities, clans, or temples, and the business is individualistic. The ore is largely gathered from the surface by individual members of the clan or village; in a few cases only are the mines operated or owned by companies. The natives are at liberty to carry away whatever ore they can gather up, with or without the payment of a small fee to the temple or community. The ore is packed on men's backs, and by little river junks to Canton, whence it is shipped to Hongkong.

A wage system prevails in the mines that are controlled by mining companies, but the great bulk of the production comes from the mines owned by communities. Milling of the ore is simple; 60 to 75 per cent grade for shipment is easily obtained by hand sorting and crude washing methods. The coolie ore dresser is paid from 30 cents to 45 cents per day; much of the ore dressing, and some of the ore carrying, is done by women and children. The wages given the carrying coolie and the coolie woman are 40 cents to 60 cents a day.

Consular reports[7] present an estimate of production costs for 1918, of 460 taels per ton concentrates delivered at Shanghai or Hongkong. At the average rate of exchange for 1918 ($1.193), and assuming Chinese concentrates at 65 per cent grade, this corresponds to a cost of $8.44 per unit. In 1920, Chinese wolframite is being delivered c. i. f. New York at less than $5 per unit.

The Chinese field is still in the initial float-ore stage, through which all tungsten districts first pass, and there is much high-grade material still available, although the cream of the surface deposits has been removed. Estimates of tonnages have not been obtained, but reports have been brought to the Commission by American exporters of the

[7] Commerce Reports, Dec. 22, 1919, Vice Consul Charles E. Kline, Shanghai.

ore to the effect that considerable quantities are yet to be recovered rom these surface deposits before the second and more expensive tage of development—underground mining—will be generally eached. A few vein deposits are already being worked.

Up to August, 1919, tungsten ore was wholly an export product. hina has no way of utilizing the ore. A plan was formulated last ear for establishing a plant at Hankow for making ferrotungsten, ut the scheme was postponed on account of the inactivity of the ungsten market. It is understood that there is a small smelting lant at Dalny, which, however, is still in an experimental stage.

Other Asiatic countries.—Nearly all the tin mines of the Malay eninsula produce more or less tungsten as a by-product. Smaller mounts are mined in French Indo-China (Tonkin) and in Siam. lost of the ore is wolframite, although some scheelite is found. The iamese area is a continuation of the Burmese and the ore is found n the surface. Laborers are paid not over 50 cents (gold) a day. he cost of production is very low, the chief expense is the Govern- ient tax (30 to 40 per cent) and the cost of bags, which is very high n that country. Permits for export were subject to the control of he British legation at Bangkok and were practically impossible to btain in 1918. The ore in that year sold for $15 to $17 a unit, . i. f. American ports.[8]

The total output of Japan and Korea (Chosen) in 1917 was prac- ically 1,770 tons (on the basis of 60 per cent concentrate), nearly ,000 tons of which came from the latter country. Korea is likely o become a more important producer, as much high-grade ore is eported from various sections and great bodies of low-grade complex re have been proved up.

Australia.—Tungsten ore has been mined in all the territories of ustralia. Queensland is the largest producer and New South Wales econd. Australia was for several years the largest producer of ungsten ores in the world, but when the surface ores were exhausted, ining languished, the output dwindled, and the United States took he premier position (1906–7). Both wolframite and scheelite are ound in nearly all the districts. The tungsten is generally associated ith molybdenite and bismuth, and is rarely found in well-defined odes. The shoots are typically erratic and hard to find. The bulk f the output comes from placer deposits of scheelite. The only ossible checks to the waning of the Australian output are the evelopment of lode mining and the solution of certain metallurgical roblems connected with the separation of the complex scheelite res. Every effort was made to increase the production after the utbreak of the war, but with little success.

[8] O. Nassauer, Report of U. S. at San Francisco, 1918, Tariff Commission Conference, p. 153.

Portugal.—Portugal has maintained its position as the chief tungsten-producing country in Europe for many years. Tungsten is found in widely separated regions in Tras Os Montes and Beira Alta (in the northerly and central sections of the country) and occurs in quartz veins of the fissure type, cutting both granite and Archaean schists. There are no deep mines, mining having stopped at or near water level. The ore is generally associated with lead, zinc, or iron sulphides in the veins and is mostly wolframite and huebnerite, though some scheelite is found. Tin and titanium are found in the country rock with no evidence of vein formation and are concentrated with the tungsten ores in alluvial deposits. The latter are an important source of tungsten. Most of the production in 1914 was by British-controlled companies, but French interests were extended after the outbreak of the war, and in 1916 American capital acquired important holdings. By an agreement with the Portuguese Government the products of the mines are shipped to England, France, and the United States, respectively. The remainder of the production, from locally controlled mines, is purchased by agents of the three foreign companies. In 1917 the average cost of production of five properties operated by hand methods was reported to be $8.22 per long-ton unit (22.4 pounds, WO_3 plus $1.07 Government tax and $0.50 freight. The estimated average cost at three plants, one British and two American, operated by mechanical methods was $7.59 plus the same charges.[9] The ore was sold at the British Government fixed price of 55s.[10]

Portugal produced the equivalent of 1,741 tons of 60 per cent concentrate in 1917. This was 57 per cent of the whole European production. Most of the product is comparatively free from tin, sulphur, bismuth, and phosphorus. There is no class of labor in Portugal corresponding to the miners and mill men of America.[11] All the workmen own small farms and only work in the mines when not engaged in harvesting. Carpenters, blacksmiths, tinsmiths, etc., turn out creditable work, considering the tools they use, but they are by nature not amenable to the introduction of modern tools or improved methods. Portuguese laborers' wages are low in comparison to those paid in the United States, as shown in the table on page 301 for 1914. Mechanical appliances, however, with consequent efficiency, are a factor in American operations.

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[9] Foote, F W., and Ransome, R. S., jr.: Eng. Mg. Jour. 106 (1918), pp. 47–53.

[10] Ibid., p. 50. The authors estimate the net value at $11.80 a long ton unit after deducting freight to England, insurance, etc. This leaves a profit margin of $2.64 a unit to the plants with mechanical equipment and $2.01 a unit to the plants working by hand methods.

[11] Digest from an article entitled "The Mineral Industry in Portugal." Foote and Ransom. Eng. Min. Jour. 106 (1918), pp. 47–52.

Typical Portuguese mine wage scale, July, 1914.

opographical engineer, per month		$49.00
ocal superintendent, per month	$35.00–	105.00
ortuguese engineer, per month	56.00–	70.00
ookkeeper, per month	28.00–	42.00
ill captain, per day		.70
ine captain, per day		.63
uard, per day		.63
iners, per day	.28–	.47
rammers, per day		.25
elper, per day	.11–	.14
lacksmith, per day		.35
arpenter, per day		.49
omen, per day	.14–	.21
ack mule and driver, per day		.70
ull cart and driver, per day		1.40

Other European countries.—Tungsten ore, chiefly wolframite, is roduced in Spain, Cornwall, France, Germany, and Austria-Hungary. he average annual output of each of these countries is approximately)0 tons. The productions decrease slightly in the order named. ussia produced 110 tons in 1917, and this was practically its first itput. A few tons are mined in Norway and Italy every year. lost of the European tungsten deposits are associated with tin mines, id the ores are generally contaminated with tin and other harmful npurities.

South America.—Wolframite, scheelite, and huebnerite are all und along the eastern cordillera in Bolivia, Argentina, and Peru id in Chile and Brazil. In 1917 Bolivia produced nearly 70 per nt of the whole South American output, and its production was most as great as that of the United States, or the third largest in ie world.

The Bolivian ores are found at high altitudes between 13,500 and 5,500 feet above sea level. Only natives accustomed to work at ich altitudes can do any physical work at these elevations; the bor supply is, therefore, limited. Transportation is difficult and the e must be sent down aerial tramways to a level where water can e had for concentration. Silver is a common associate of the tungen and is usually present in sufficient value to warrant a preliminary aching of the ore with hyposulphite of lime to extract the precious etal before the mechanical concentration for the recovery of the ngsten. As the tungsten veins are often crossed and intertwined ith tin veins, the mining of the two metals goes hand in hand, and ie concentration of the mixed ore involves this difficult separation vhich is rarely complete). Copper is another unwelcome associate id there is generally some bismuth.

About 70 per cent of the Bolivian output comes from the Department of Oruro, 20 per cent from La Paz, and the remainder from Potosi. The mines are owned by Chilean, English, French and American capital. Approximately 75 per cent of the production is exported to the United States, most of the remainder to England in 1917; but in that year there was much competitive buying by French and British commissions, and in 1918 a larger part of the ore was diverted to Europe.

Argentina is the second largest of the South American producers. Tungsten and petroleum are practically its only mineral products. The chief production has come from a mine in the Sierra Cordoba controlled by the Hansa Sociedad de Minas, a German concern.[12] The Argentine ore was all shipped to Germany before the war and in 1917 operations were temporarily suspended. Later the output was contracted for by American firms and production resumed and increased. In 1917–18 there were large shipments to Europe as well as to the United States.

Most of the Peruvian mines are owned and operated by native capital. The tungsten minerals are huebnerite and wolframite, and are generally accompanied by considerable, even economical, amounts of copper. As in most Andean mines, development and operation are hindered by the extreme difficulty of transportation. Only a few mills have been erected and most of the concentrating is done by women who hand pick the coarse material and pan the fines. In 1916–17 English interests secured an option on the Huara deposits in the Province of Ancachs. These have been reported as the largest bodies of tungsten ore in the world.[13]

In common with most mineral products, tungsten ore exports from nearly all South American countries are subject to an export tax which is generally based on a sliding scale depending on the price of the ore as well as the financial necessities of the individual country. These taxes are constantly fluctuating.

Canada.—No important discoveries of tungsten minerals have been made in Canada. A small and fairly steady output of scheelite has been maintained in Nova Scotia, largely as a by-product of the treatment of gold ore. A sporadic production has been reported from British Columbia, New Brunswick, and Ontario.

Mexico.—Since 1915 small shipments of tungsten have been made from various parts of Mexico, especially Sonora. Much of it has been marketed at a comparatively low price, being stolen ore or ore mined by "high-graders." It is handled at Douglas, Ariz., by American or-

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[12] Mineral industry, XXIII (1914), p. 750. A characteristic feature of the Cordoba ore is the presence of appreciable amounts of the very rare metal niobium; some specimens run as high as 1.5 per cent niobium oxide (Nb_2O_5).

[13] Min. Jour., Mar. 3, 1917.

low-grade deposits can be systematically developed and equipped for production on a large tonnage basis.

Foreign costs are much more difficult to ascertain; they apparently range, in various lands, from $2 to $20 per unit (20 pounds WO$_3$). Many of the estimates obtained by the Tariff Commission run considerably above the prices that the British Government was paying to producers during the war period and are manifestly too high. On the other hand, it is stated that much of the Burmese ore is produced for less than $2 per unit. There is little uniformity in the figures and no definite conclusions can be drawn from such data. A better index is the record of sales in the consuming markets. As soon as shipping restrictions were removed after the signing of the armistice a flood of tungsten ore came to the United States from China and the Far East. This material was sold as low as $6 per unit on the New York market and most of it changed hands at less than $8 per unit. Some of these sales may represent liquidation of stocks with slight regard to profits, and a little of it may even have been sold below the delivered cost. Nearly a year after the embargoes were removed, this ore was offered at $7 per unit in New York. Chinese ore is being sold on the New York market in some quantity at less than $5 per unit.[14]

Costs in other far eastern countries and Bolivia and Portugal must be judged by the prices at which their product is sold in consuming markets. On this basis they come between the very cheap Chinese (and Burmese) material and the more expensive production of the United States. The British Government controlled prices on tungsten ore—drawn from Burma, Portugal, and Bolivia—have ranged from $13 in 1918 to $6.25 in early 1919. It can be stated authoritatively that small tonnages of Bolivian concentrates are available (1920) for delivery c. i. f. New York at $7.50 to $8.00 per unit. The bulk of the Bolivian production is at a cost considerably above this, but the ore would appear in the New York market, in limited amounts, at about this figure.

MARKETS AND MARKETING.

In the prewar period Germany was the clearing house for most of the tungsten ore mined in the world, and a large part of the tungsten powder and ferroalloy produced was manufactured in that country and furnished to steel makers throughout the world. Most of the American production, however, has always found a ready market at home. The world situation was abruptly changed by the outbreak of the war and the elimination of the Central Powers from general commerce. Great Britain, controlling more than half of the tungsten

[14] Data from importers.

output of the world, became the logical center of the industry. The construction of reduction plants was started at once and these were soon able to take double the amount of ore readily obtainable. The steadily growing demands of American steel makers, which far exceeded the domestic production of ore, resulted in active competition between British and American interests for South American and Asiatic ore, and even for the Portuguese output. In an attempt to straighten out this tangle of interests, a tentative contract was drafted in 1917–18 whereby each country should retain control of all tungsten produced in its own territory, while that produced in other countries was to be equally divided between the two contractors. In view of the fact that fully two-thirds of all the tungsten output of the world was produced in British-controlled territory, this agreement would have been manifestly disadvantageous to the American industry, whose requirements exceeded those of the British steel makers, and it was never consummated.

The chief market for tungsten ore in the United States is in the Eastern States, especially in the vicinity of Pittsburgh. Only a small part of the total domestic concentrate is reduced in Western States closer to the mines; most of the concentrate must be shipped East.

Many tungsten concentrates contain deleterious impurities which impair their value as sources of ferrotungsten. Most metallic impurities are reduced along with the tungsten in the electric furnace if not removed beforehand, and hence would go into the steel and injure its quality. Objectionable impurities are antimony, arsenic, bismuth, copper, lead, nickel, tin, zinc, phosphorus, and sulphur. Fortunately for the American producer, domestic ores are singularly free from the more objectionable impurities. Most foreign ores contain them in greater or less amounts, and, consequently, almost invariably sell at a discount.

The usual quotations for tungsten ore are based on material containing 60 per cent tungsten trioxide and no objectionable impurities.[15] Separate quotations are sometimes published for wolframite and scheelite. The latter is more easily reduced in the electric furnace and commonly valued $1 or more a unit higher than wolframite. A slightly better price can be gotten for ferberite than for wolframite, while huebnerite sells for a little less than the standard ore. The removal of a large manganese content in the electric furnace is difficult, and since it tends to lower the grade of the ferroalloy, it is undesirable.

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[15] Foote Mineral Co. specifications for commercial grade, guaranteed: Tungsten trioxide, minimum, 60 per cent; sulphur, copper, and phosphorus, each, maximum, 0.05 per cent.
Tin or bismuth, absent or traces.
$2 to $8 per unit penalty for excess impurities beyond above allowance.

the United States and sold, was produced in 1900. At that time the price of tungsten trioxide was about $2 per unit in a 60 per cent concentrate. With the betterment in price the production increased

[8] Statement of W. F. Bloecker, Report of U. S. Tariff Commission Conference at Denver, p. 203 et seq.

slowly. In 1906 there was a remarkable increase and at the beginning of 1907 the price had risen to from $9 to $14 a unit. During the first part of 1907 business was good and there were large gains in production both in the United States and in foreign countries. Near the end of the year came the depression in the steel industry and the panic of 1907–8. The tungsten industry was temporarily crippled. Prices dropped to $5 a unit in the latter part of the year and continued at that level through the early part of the following year with production at a low ebb. Late in 1908 prices improved and the tungsten industry responded rapidly to an active demand. Production came back in 1909 to almost the high record of 1907 and in 1910 exceeded it. Then came another depression in the steel industry which was naturally reflected in the tungsten price and production. The period from 1912 up to the outbreak of the world conflict was one of slow recuperation from the 1911 setback. Improvement in price was not so rapid as in 1909, when the declining output from Australia strengthened the market. Burma began to produce tungsten in 1910 and immediately became an important factor in the world market. Only the more general recognition of the valuable properties of the black metal prevented an actual slump in prices. In the early part of 1914 there was a slack demand for tungsten and a tendency toward sagging prices, most sales being made on a basis of about $6.50 a unit. The outbreak of the war in August nearly paralyzed tungsten mining, and it was not until toward the end of the year that the demand quickened. Prices as high as $9 a unit were offered but throughout the year the price depended on the quality and quantity of ore and the urgency of the needs of buyers and sellers. The market was not general or active. Production fell off 35 per cent.

In the first quarter of 1915 the domestic production was at about the same rate as in 1914 and 60 per cent concentrates sold as low as $5.80 a unit. War orders were beginning to pour into the United States from England and France and caused a great demand for tungsten for high-speed cutting tools and other special steels. The British Government placed an embargo on the exportation of tungsten ore and products from Burma and all British possessions. This embargo temporarily cut off all sources of foreign supply, importations of tungsten suddenly and almost completely stopped, and consumers turned to the domestic producers for their supplies. Prices began to soar; in May the value of tungsten concentrates had almost doubled and before the end of the year there was a frantic demand at $50 and $62.50 a unit. Mining of all known deposits was pushed and there was active prospecting for new deposits under the stimulus of record prices. As a result the 1915 output was nearly 140 per cent greater than that of 1914 and the greatest in the previous

history of tungsten mining in this country and its value was nearly two and a half times as great as that for any previous year.

The boom that started in the latter part of 1915 expanded at an enormous rate in the early months of 1916 and reached its climax in April, when sales were made at the record price of $82.50[17] a unit, compared with $7.32, the average price in 1914. Before the middle of May the market broke, and quotations at the end of May were less than half those of the preceding month, buyers taking only what they needed for immediate use. The hesitancy of consumers to make purchases together with a forced restriction in consumption allowed stocks to accumulate and the great activity of producers hastened the continued decline. In August the market steadied, while consumers satisfied their most pressing requirements at prices averaging only a little more than $25 a unit. The first week in September was marked by another precipitate decline, but the market soon found its level at about $17 and this price prevailed with a slight upward trend to the end of the year.

The abnormal market stimulus in the spring of 1916 aroused great excitement in all tungsten districts. Speculation in mines was even greater than in the ore and metal market. The wildest scramble for tungsten properties was that in Boulder County, Colorado. Clerks, waiters, farm hands, miners, and promoters all joined in a feverish search for showings of tungsten ore. The mad rush came when the ground was covered with snow, and little could be judged as to the value of the various claims and prospects, many of which changed hands several times a day. Thousands of dollars were paid for options, merely on hearsay evidence. Before the snow was gone and real prospecting and development could commence the bubble had burst. A number of "leasers" stayed and a few prospectors remained to work their claims, but most of the speculators and fortune seekers drifted away without in any way adding to the output of the ore. Nevertheless the high prices of 1916 caused the reopening of many abandoned mines and brought about the discovery of some new deposits. After a few months' development the output began to grow. On July 1, in only six months, an equivalent of over 3,000 tons of 60 per cent concentrates had been produced—more than the United States or any other country had ever produced in any 12 months previous to that time. The total production for the year was equivalent to 5,923 tons of 60 per cent concentrate, valued at $12,075,417.

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17 "In one instance, at least, upward of $100 a unit was paid * * *." Report of U. S. Tariff Commission Conference at Denver, p. 180.

quoted at $10 in September and $10.50 in October, and scheelite at $15 in September. In 1920 prices sagged further. In July sheelite is quoted at $7 per unit and wolframite from $6.50 to $7.50 f. o. b. mine.

Average monthly price of tungsten ore.[1]

[In dollars per unit, WO_3.]

Month.	1917		1918	
	Wolframite.	Scheelite.	Wolframite.	Scheelite.
January	17.14	17.50	24.75	26.00
February	16.80	17.50	24.50	26.00
March	17.17	17.77	24.00	24.55
April	17.86	19.04	24.00	24.50
May	19.10	20.94	24.00	24.15
June	20.80	23.50	24.00	24.00
July	23.44	25.68	24.00	24.00
August	24.66	26.50	24.50	25.05
September	23.92	26.00	24.50	25.35
October	24.00	26.00	25.00	26.00
November	26.00	26.00	(2)	(2)
December	25.24	26.56	(2)	(2)
Year	21.34	22.75	24.325	24.95

[1] Engineering and Mining Journal quotations.
[2] No market.

DOMESTIC CONSUMPTION AND SOURCES OF SUPPLY.

The United States has become one of the largest consumers of tungsten in the world. While it has also been one of the largest producers, the domestic output has always been insufficient to satisfy the demands of consumers and the balance has to be imported.

Relation of domestic production to consumption.

Calendar year.	Domestic production (short tons).[1]	Imports for consumption (short tons).[2]	Domestic exports.	Ratio to production: Imports (per cent).	Value (imports for consumption).	Amount of duty.	Import value per unit of quantity per short ton.	Equivalent ad valorem rate (per cent).
1910	1,821	([3])	([4])	.....	[5]$178,174	[5]$17,817.40	.....	10.00
1911	1,139	([3])	([4])	.....	85,887	8,588.70	.....	10.00
1912	1,330	824	([4])	62.00	362,422	36,242.20	$439.83	10.00
1913	1,537	449	([4])	29.21	213,122	[6]19,169.60	474.65	10.00
1914	990	299	None.	30.20	139,687	Free.	467.18	.....
1915	2,332	1,534	None.	65.78	1,044,986	Free.	681.22	.....
1916	5,923	3,973	None.	67.08	7,353,691	Free.	1,850.92	.....
1917	6,144	4,876	None.	79.36	4,465,590	Free.	915.83	.....
1918	5,041	11,750	None.	233.09	11,552,218	Free.	983.17	.....
1919	.....	9,408	None.	.....	6,261,190	Free.	745.38	.....

[1] Calculated into equivalent tons of 60 per cent WO_3.
[2] Not corrected. No data as to equivalent tons of 60 per cent WO_3.
[3] Weights not recorded prior to July 1, 1911.
[4] No statistics.
[5] Six months ending Dec. 31, 1910.
[6] Duty from Jan. 1 to Oct. 3, 1913, under act of 1909

Most of the foreign supply came from Germany before the war in the form of both tungsten ore and as metal or ferrotungsten, but Germany was eliminated at the outbreak of the world conflict and

the United States has fallen back on South America and China to supplement its domestic supplies. This change in sources of supply has also wrought a change in the character of the imports. Since there are no tungsten reduction works in South America, the tungsten supply in later years has been imported almost wholly in the form of ore to be reduced in this country. No tungsten is exported in the form of ore, but there are appreciable quantities of ferrotungsten shipped out of the United States. In considering the needs of the United States account should be taken of these exports of a comparatively crude form. A close approximation to recent actual consumption of tungsten is obtained in the table on page 311. The data are based on 60 per cent concentrate (e. g., 60 per cent WO_3), assuming that 1 ton of ferrotungsten is equivalent to 2 tons of concentrate.

Domestic consumption of tungsten, expressed in 60 per cent concentrates (60 per cent WO_3).

[Calendar years.]

	1913		1917		1918	
	Short tons.	Per cent.[1]	Short tons.	Per cent.[1]	Short tons.	Per cent.[1]
Imports[2]	1,929	55.65	4,878	44.26	11,750	69.98
Domestic production[3]	1,537	44.35	6,144	55.74	5,041	30.02
Total supply	3,466	100.00	11,022	100.00	16,791	100.00
Exports[2 4]	(5)	.....	2,324	21.09	1,232	7.34
Domestic consumption	3,466	100.00	8,698	78.91	15,559	92.66

[1] Per cent of total supply.
[2] Data compiled from Department of Commerce records. Ferrotungsten and metal converted at the rate of 1 ton ferro and metal equal 2 tons concentrates.
[3] Data from Geological Survey: Mineral Resources, Preliminary Report, 1918, p. 101.
[4] Figures are for tungsten metal and ferrotungstan; no tungsten ore was exported from the United States.
[5] There were no exports prior to 1914.

The above table clearly shows the great increase in the consumption of tungsten in the United States, not only the consumption of concentrates that are merely made into ferrotungsten or tungsten metal, but also the net consumption that goes into ultimate manufactures. The reduction of concentrate is a comparatively minor industry, and has developed in the United States, merely as a matter of convenience, just as Germany was formerly the brokerage market as well as a consuming market. The tungsten exports are wholly of metal or ferrotungsten. Since there is no duty on tungsten ore, no records are kept of the portion of these exports derived from domestic and from foreign ore. If the ore were dutiable, most of these exports would have been "smelted in bond" or "exported with benefit of drawback."

The development of tungsten ore reduction for export is a direct result of the transfer of sources of supply, which are also indicated in the above table.

IMPORTS.

Before the war, Germany furnished the United States with about two-thirds of its imported supply of tungsten ores in addition to large amounts of tungsten metal and ferro-alloy. Since Germany in normal times produced only 100 or 200 tons of tungsten ore a year, it is evident that Germany was not the country of origin of the large importations received in the United States, and that they were chiefly of ore produced in other countries and reexported from Germany. Until the outbreak of the war practically all the tungsten ore output of the world, with the exception of that of the United States and certain European countries, was sold to German buyers. The German firms were ready to purchase and treat ores containing objectionable impurities and low-grade material that British buyers would not touch and, naturally, a large part of the world output gravitated to this market. Most of this ore was made into metal or ferrotungsten in Germany,[18] but the German ore buyers did some brokerage business and reshipped an important tonnage of the better class of ore, especially to the United States. In 1913 (fiscal year) the United States imported a total of 858 short tons of tungsten ore, of which 672 short tons came from Germany.

Just preceding the war there was little demand for tungsten and imports fell off. The sudden demand in 1915 was only partially met by the increased domestic production. Germany was cut off as a source of supply because of the war. American consumers began to draw supplies direct from South American sources and in 1917 (fiscal year) nearly 80 per cent of the 4,281 tons of tungsten ore imported into the United States came from Peru, Chile, Argentina, Panama, and Ecuador. The imports from Panama were reshipments from Costa Rica, Ecuador, and Colombia. A large part of the imports from Chile, Peru, and Ecuador is of ore produced in Bolivia.

In general, imported ore has a higher tungsten content than the domestic product. A little of it grades down to 50 per cent WO_3, but the average is close to, and probably slightly over, 60 per cent. Chinese wolframite, which is the only ore now (1920) entering the American market, averages 65 to 70 per cent tungstic oxide. Foreign ore is rarely free from objectionable impurities. Much of it can not be treated directly by the electric furnace plants, but is taken up at low prices by companies equipped to treat it by chemical processes.

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[18] In the 5-year period 1909–1913, the net imports of tungsten ore into Germany averaged 3,600 tons a year. Report of British Royal Commission.

Imports by countries.

[Fiscal years.]

Imported from—	1912[1]		1913		1914		1915	
	Short tons.	Value.	Short tons.	Value.	Short tons.	Value.	Short tons.	Value.
rmany	261	$115,307	672	$300,867	140	$78,709	12	$8,692
rtugal	67	29,703	90	41,732	78	37,063	38	17,558
ain	24	11,532	.....	.....	.....	.....	18	7,095
ited Kingdom	54	23,212	76	34,557	25	13,519	196	84,891
nada	.....	.....	13	6,789	.....	.....	.....	.....
aits Settlements	.....	.....	7	2,684	.....	.....	.....	.....
ile	.....	.....	.....	.....	.....	.....	21	10,531
ru	.....	.....	.....	.....	.....	.....	173	72,553
uguay	.....	.....	.....	.....	.....	.....	7	2,340
pan	.....	.....	.....	.....	.....	.....	27	11,492
Total	416	179,754	858	386,629	243	129,291	492	215,152

Imported from—	1916		1917		1918		1919	
	Short tons.	Value.	Short tons.	Value.	Short tons.	Value.	Short tons.	Value.
rtugal	260	$286,444	43	$41,007	103	$82,583	.....	.....
ain	19	15,618	.....	.....	.....	.....	.....	.....
ited Kingdom	35	23,361	.....	.....	.....	.....	.....	.....
nada	.....	100	.....	.....	12	36,000	64	$92,613
aits Settlements	.....	.....	.....	.....	.....	.....	56	44,688
ile	880	2,017,145	1,576	2,013,411	1,521	1,364,461	896	859,936
ru	896	1,223,001	1,223	1,073,001	1,711	1,455,863	1,007	870,363
uguay	27	27,242	.....	.....	.....	.....	.....	.....
pan	405	791,568	320	374,404	1,081	1,157,329	1,396	1,793,680
xico	195	36,677	340	192,330	295	214,072	135	135,722
gentina	418	684,677	503	1,062,604	281	371,227	382	488,317
livia	84	203,767	.....	.....	73	82,542	76	94,841
nama	3	7,600	157	144,558	26	26,143	13	17,677
uador	.....	.....	6	5,300	11	12,559	.....	.....
ina	28	12,768	56	42,747	850	723,935	8,028	7,411,470
m	28	22,778	56	48,877	22	17,166	.....	.....
l other	93	100,886	1	1,259	337	249,818	152	189,030
Total	3,371	5,453,632	4,281	4,999,498	6,323	5,793,698	12,205	11,998,337

[1] Included in "All other articles" prior to 1912.

ports of tungsten-bearing ore into the United States from all countries during 1919.

Country.	January.		February.		March.		April.		May.	
	Short tons.	Value.	Short tons.	Value.	Short tons.	Value.	Short tons.	Value.	Short tons.	Value.
xico	65	$63,375	.....	.....	.....	.....	.....	.....	5	$2,614
gentina	17	26,907	.....	.....	.....	.....	.....	.....	.....	.....
ile	43	43,511	70	$88,080	27	$20,818	39	$48,121	1	1,661
lombia	1	1,312	.....	.....	.....	.....	.....	.....	.....	.....
ru	19	28,050	67	62,752	43	37,486	63	40,669	29	26,500
ina	302	293,772	475	442,626	110	51,405	28	11,474	59	25,178
ngkong	531	456,219	534	502,989	564	502,523	202	192,899	169	144,658
nama	.....	.....	.....	172	.....	.....	.....	.....	.....	.....
livia	.....	.....	16	9,994	.....	.....	.....	.....	.....	.....
osen	.....	.....	52	58,375	.....	.....	.....	.....	.....	.....
pan	.....	.....	505	645,886	12	13,388	.....	.....	.....	.....
nada	.....	.....	.....	.....	.....	.....	20	12,750	.....	.....
raits Settlements	.....	.....	.....	.....	.....	.....	.....	.....	56	44,688
Total	978	913,146	1,719	1,810,864	756	625,620	352	305,913	319	255,299

Imports of tungsten-bearing ore into the United States from all countries during 1919—Continued.

Country.	June.		July.		August.		September.		October.	
	Short tons.	Value.	Short tons.	Value.	Short tons.	Value.	Short tons.	Value.	Short tons.	Value.
Mexico			44	$38,540						
Argentina	56	$40,000			13	$3,377	22	$16,205		
Chile	152	84,600	101	64,143	139	67,480	92	82,899	67	$35
Peru	111	50,337	3	5,764	3	1,636	15	7,374	47	2
China			90	58,506	146	50,836	78	24,956	235	10
Hongkong			209	36,352	318	107,708	534	197,251	155	5
Bolivia			59	41,045			93	38,917	129	3
Japan	59	57,780					82	40,801	30	1
Total	378	232,717	506	244,350	619	231,037	916	408,403	663	26

Country.	November.		December.		Total.	
	Short tons.	Value.	Short tons.	Value.	Short tons.	Value
Canada					20	$1
Panama						
Mexico					114	10
Argentina			37	$25,000	145	1
Bolivia	239	$79,008	9	8,287	545	2
Chile	108	55,836	151	92,273	985	6
Colombia					1	
Peru			31	18,500	431	2
China	908	408,005	379	141,376	2,810	1,6
Hongkong	187	55,046			3,403	2,2
Chosen					52	5
Straits Settlements					56	4
Japan	158	82,160			846	8
Total	1,595	680,055	607	285,436	9,408	6,2

A heavy influx of Chinese ore in 1919 is to be noted from the above table. Of a total import of 9,408 short tons from all countries during the entire year 1919, two-thirds (6,213 tons, or 66 per cent) were from China. This material had an import valuation of $3,873,55. Its WO_3 contents are not known, but if estimated at 70 per cent, the import valuation per unit would be $8.91. This Chinese ore, although merely hand sorted, frequently runs over 70 per cent WO_3.

Imports for consumption—Revenue.

Fiscal year.	Rate of duty	Quantity (short tons).	Value.	Duty collected.	Value per unit of quantity.	Actual and computed ad valorem rate (per cent).
1910[1]	10 per cent		$272,311	$27,231.10		1
1911	do		241,795	24,179.50		1
1912	do	427	184,518	18,451.80	$432.13	1
1913	do	858	386,629	38,662.90	450.62	1
1914[2]	do	11	5,237	523.70	476.09	1
1914[3]	Free	255	124,054		486.49	
1915	do	491	215,152		438.19	
1916	do	3,373	5,453,632		1,616.85	
1917	do	4,181	4,999,498		1,196.77	
1918	do	6,430	5,880,473		914.54	
1919	do	12,232	12,041,496		984.43	

[1] Aug. 6, 1909, to June 30, 1910.
[2] July 1 to Oct. 3, 1913, under act of 1909.
[3] Oct. 4, 1913, to June 30, 1914, under act of 1913.

Calendar year.	Domestic production.[1]	Imports for consumption.	Available supply.[1]	Available supply produced in United States.
	Short tons.	*Short tons.*	*Short tons.*	*Per cent.*
1912	1,330	824	2,154	62.7
1913	1,537	449	1,986	77.4
1914	990	290	1,280	78.1
1915	2,332	1,534	3,866	60.3
1916	5,923	3,973	9,896	59.9
1917	6,144	4,876	11,020	55.8
1918	5,041	11,750	16,791	30.0

[1] Production calculated into tons of 60 per cent WO_3. No data for correcting import tonnage to 60 per cent bases. Available supply does not include the imports of ferrotungsten and metal (Small.)

From 1912 to 1917, the domestic production exceeded the imports, but in 1918, the consumption of foreign ore in the United States exceeded that from domestic mines. As has been noted elsewhere this increase in percentage of foreign ore is partly attributable to the fact that in recent years there have been no imports of ferrotungsten and some ferrotungsten has been exported. The main reason, however, is that domestic production was handicapped because of the drop in price and the competition of foreign supplies.

The production of tungsten in every country passes through an early stage of comparatively cheap output from float ore and rich easily-mined surface deposits. Practically no equipment or investment is required and the labor necessary to secure the ore is much less than is required at a later period, when the supply of ore must

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UNITED STATES TARIFF COMMISSION
WASHINGTON

Tariff Information Series—No. 22

CENSUS OF DYES AND COAL-TAR CHEMICALS

1919

WASHINGTON
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1921

UNITED STATES TARIFF COMMISSION.

Office: 1322 New York Avenue, Washington, D. C.

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THOMAS WALKER PAGE, *Chairman.*
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LETTER OF TRANSMITTAL.

UNITED STATES TARIFF COMMISSION,
Washington, December 6, 1920.

TO THE PRESIDENT:

The Tariff Commission transmits herewith a report showing the results of the census of production of dyes and related coal-tar chemicals for the year 1919. This census is taken in conformity with your letter of October 27, 1917, requesting the Tariff Commission to secure the information on the relation between the domestic production and the imports of dyes and other coal-tar chemicals, required by section 501 of the act of September 8, 1916.

Very respectfully,

THOMAS WALKER PAGE, *Chairman.*
DAVID J. LEWIS.
WILLIAM S. CULBERTSON.
EDWARD P. COSTIGAN.

THE PRESIDENT,
The White House, Washington.

INTRODUCTION.

This report is a survey of the domestic dye and coal-tar chemical industry in 1919, and presents the results of a special investigation made by the United States Tariff Commission. The report is divided into four parts, as follows:

PART I, *a summary of the developments in the coal-tar chemical industry, 1919*, describes the progress made in the various branches of the American industry. The relation of export trade to the industry is briefly shown.

PART II, *a census of dyes and coal-tar chemicals, 1919*, gives a detailed discussion of the significant facts in the production of crude, intermediate, and finished coal-tar products during 1919. Dyes are classified by their methods of application, and imports in 1914 are compared with production in 1917, 1918, and 1919. The number of employees, rates of pay, and cost of research in the coal-tar chemical industry are shown.

PART III, *a census of dyes imported into the United States from July 1, 1919, to June 30, 1920*, shows the quantity and value of imports of individual dyes.

PART IV, *an appendix*, gives the imports and exports of coal-tar dyes and chemicals and of natural dyes since 1917. A list of manufacturers whose production during 1919 was reported to the Tariff Commission is also shown.

In the preparation of this report the Tariff Commission has had the services of A. R. Willis, Warren N. Watson, C. R. De Long, and Grinnell Jones, of the chemical division, and others of the commission's staff.

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Part I.—SUMMARY OF THE DEVELOPMENTS IN THE COAL-TAR CHEMICAL INDUSTRY DURING 1919.

INTRODUCTORY.

The Tariff Commission, in several earlier reports,[1] has described the importance of a well-developed dye industry to the industrial system of the country. These reports have also shown in detail the progress of the American industry during 1917 and 1918. The commission has also presented information relating to the cost of production of certain important intermediates and dyes. The commission[2] has analyzed the existing tariff law on dyes and related chemicals of coal-tar origin and on the raw materials from which these products are obtained and has made suggestions for such a redrafting of this law as would give effect to the intent of Congress in passing the act of September 8, 1916. The present report is, therefore, confined to a discussion of the progress which has been made in the American industry during the calendar year 1919. This report also presents the available information on the condition of the dye industries of Germany, England, Switzerland, France, and Japan.

The account of the progress of the industry, as given in the following pages, is based upon detail reports from 214 manufacturers, and, it is believed, that the canvas includes every manufacturer of dyes and other coal-tar chemicals in the United States. The investigation was carried out in conformity with a request of the President to secure information necessary to administer section 501 of the act of September 8, 1916. The production reports of individual manufacturers were collected by the Bureau of Census and transmitted to the Tariff Commission for tabulation and interpretation.

In the tariff act of September 8, 1916, the coal-tar chemicals are divided into three groups, which conform in general (although not in every detail) with commercial practice. Group I, the crudes, exempt from duty, which are contained in and separated from crude coal tar; Group II, intermediates, dutiable at 15 per cent and 2½

[1] Census of Dyes and Coal-Tar Chemicals, 1917; Report on Dyes and Related Coal-Tar Chemicals, 1918; Census of Dyes and Coal-Tar Chemicals, 1918; and Costs of Production in the Dye Industry, 1918 and 1919.

[2] Dyes and Other Coal-Tar Chemicals, Dec. 12, 1918.

cents per pound, which are produced from the crudes by chemical processes, and which, with some exceptions, are used only for the manufacture of dyes or other finished products by further chemical treatment; Group III, dyes and other finished products, now dutiable in part at 30 per cent and in part at 30 per cent and 5 cents per pound. This grouping is adhered to in the following discussion of the industry.

IMPORTANT DEVELOPMENTS IN THE DOMESTIC INDUSTRY.

The development in the production of coal-tar chemicals in this country during 1919 is shown by comparing the production of that year with the production during 1918.

TABLE 1.—*Summary of the production of coal-tar chemicals, 1918 and 1919.*

	1918			1919		
	Number of manufacturers.	Quantity.	Value.	Number of manufacturers.	Quantity.	Value.
		Pounds.			*Pounds.*	
Group I.—Crudes[1]	35	.....	$22,474,075	24	.....	$17,657,770
Group II.—Intermediates	128	357,682,251	124,382,892	116	177,362,426	63,210,079
Group III.—Finished products	.....	76,802,959	83,815,746	155	82,532,390	84,585,544
Dyes:						
Dutiable at 30 per cent plus 5 cents per pound	.....	53,825,677	58,255,391	.....	52,310,482	59,950,[illegible]
Dutiable at 30 per cent	.....	4,638,769	3,770,991	.....	11,091,712	7,648,333
Total of dyes	78	58,464,446	62,026,390	90	63,402,194	67,598,[illegible]
Color lakes, dutiable at 30 per cent plus 5 cents per pound	29	9,390,537	5,020,023	34	7,569,921	4,179,964
Photographic chemicals, dutiable at 30 per cent plus 5 cents per pound	6	316,749	823,915	10	335,509	1,059,340
Medicinals, dutiable at 30 per cent	31	3,623,352	7,792,964	31	6,777,988	7,983,071
Flavors, dutiable at 30 per cent	7	458,256	4,925,627	9	610,825	1,315,654
Synthetic phenolic resins, dutiable at 30 per cent plus 5 cents per pound	5	4,233,356	2,642,120	5	3,794,534	2,381,358
Tanning materials (synthetic)	1			1		
Perfume materials	6	116,263	584,695	6	41,419	164,382

[1] Production of coal-tar distillers does not include production of crudes at by-product coke ovens, which was reported to United States Geological Survey.

Crudes.—One of the outstanding developments during 1919 which is of significance in considering the future of the coal-tar chemical industry is the increase of 17.2 per cent in the productive capacity of by-product coke ovens in the United States. The production of coke in by-product ovens was 56.2 per cent of the total production, and thus for the first time exceeded the output of the wasteful beehive ovens. There is no question that, with the possible exception of anthracene, adequate supplies of fundamental raw materials are now available from domestic sources for the future growth

and expansion of the coal-tar chemical industry in the United States. In 1919 considerable progress was made as to supplies of anthracene, the output of this important material being about three times the production of 1918. Moreover, a larger proportion of it was refined. Although this shows encouraging progress, a much greater increase in output must be secured before there will be a sufficient supply of anthracene for alizarin and vat dyes. It may be roughly estimated that the 1919 production contained about one-fifth the amount of pure anthracene required for American needs. The difficulty in securing adequate supplies of anthracene is the most important and fundamental problem awaiting solution in the dye industry. Important work is under way which points to the solution of this problem in the near future. When a sufficient supply of anthracene is secured an adequate production of alizarin and vat dyes will soon follow.

The value of the crudes produced during 1919, as shown in Table 1, does not represent the total production in the United States, as those crudes produced at by-product coke ovens were reported to the United States Geological Survey and are not available at the present time. Complete information is therefore not at hand for an accurate analysis of the production of these raw materials in the United States during 1919.

Intermediates.—From Table 1, it is apparent that the total production of intermediates decreased from 357,662,251 pounds in 1918 to 177,362,426 pounds in 1919. This falling off was due to decreases in the output of certain intermediates which were used during 1918 in the manufacture of explosives and poison gases, or which were made during 1918 with the expectation of future military demands. The signing of the armistice left on hand large stocks of these intermediates and during 1919 they were diverted to the manufacture of dyes or other finished products. The most conspicuous example of this kind is phenol, which decreased from 106,794,277 pounds in 1918 to about 1,543,659 pounds in 1919. At the signing of the armistice about 35,000,000 pounds of phenol were on hand awaiting conversion into explosives. Other similar cases include benzene sulphonic acid, monochlorobenzene, dinitrotoluene, diphenylamine, nitronaphthalene, and dimethylaniline, all of which were used in substantial amounts in making military explosives as well as in dye making. If these intermediates are eliminated from consideration, those remaining show a gain of over 10 per cent in production in 1919 as compared with 1918. However, this gain in gross output does not measure the progress of this branch of the industry. Of much greater importance was the appearance of about 76 intermediates that were not made during 1918, and many substantial increases in the amount

produced of certain intermediates which are comparatively difficult to make, but which are needed for dyes of high quality.

Dyes.—During 1919 the total output of dyes was 63,402,194 pounds valued at $67,598,855, an increase of about 8 per cent in quantity as compared with 1918. The production in 1919 exceeded by 38 per cent in quantity the imports during the fiscal year 1914. The increase in total output by no means measures the whole improvement in the situation. An analysis of the figures for 1919 shows many instances of substantial decrease in those dyes which are relatively easy to make and also of those needed in large amounts during 1918 for Army and Navy uniforms. Decreased output of these particular dyes has been more than offset by the increased output of dyes of better quality, many of which were made for the first time in the United States during 1919.

The domestic industry has been especially successful in the production of those colors for which there exists a large and constant demand. Sulphur black, which is consumed in the United States in larger amounts than any other color, was produced to the extent of 14,504,770 pounds by 13 manufacturers. Some of the American brands are superior in quality to the best products imported from Germany before the war. Another notable achievement was the production during 1919 of indigo in amounts exceeding our prewar import. This dye, which ranks second in consumption by the United States, ranks first in world consumption on account of its large use in China.

As has been pointed out in earlier reports of the commission, during 1915 and 1916 the new American dye industry naturally sought the line of least resistance by making the dyes which were easiest to make, and the consumers used whatever dyes they could get instead of the varieties they preferred. As a result there were many cases of enforced substitutions of both German dyes (available from stocks) and American dyes. This substitution in early years of the war materially damaged the reputation of American dyes. During the succeeding years there has been a steady and progressive improvement in the situation. Although consumers were better supplied with the particular dyes they desired in 1919 than they were in 1918, there were still needed certain types of dyes which could not be supplied from American sources in the quantity desired. Thus in 1919 there was an insufficient domestic output of vat dyes which, on account of their extreme fastness and beauty of shade, are important for cotton shirtings, ginghams, and calicos. Considerable progress has been made, however, toward supplying these much-needed colors. There is also a demand for many individual dyes of other classes which are not yet available at all or only in inadequate amounts

This is particularly true of alizarin derivatives and of certain other specialties.

Export trade in dyes.—The domestic production of *certain* dyes has developed to a point beyond the quantity necessary for domestic consumption, and a large surplus has been available for export to foreign markets, particularly Japan and China. During the calendar year 1919 the United States exported "dyes and dyestuffs" to the value of $17,084,435, of which $10,724,071 represented aniline dyes, $1,355,936 logwood extract, and $5,004,428 other dyes. For the nine months ending September 30, 1920, the domestic exports of dyes and dyestuffs amounted to $26,032,389, of which $17,038,235 was aniline dyes, $2,321,090 was logwood extracts, and $6,673,064 was other dyes. This sum for the nine months of 1920 is more than double the exports during the same period in 1919 and also exceeds the value of total imports during the fiscal year 1914. The actual quantity exported, however, is smaller than the prewar import, and the increase in value is due to a higher value per pound. During 1919 and 1920 (nine months) Japan and China took about one-third of our total exports of dyes.

In estimating the significance of this achievement of the domestic industry in the exportation of dyes it should be remembered that domestic manufacturers during 1919 and 1920 have met little competition in foreign markets from German dyes. It should also be pointed out that any deductions as to the competitive strength of the domestic industry which are based on exports of dyes do not take into consideration the fact that the domestic industry is still deficient in the important group of vat and alizarin dyes.

The coal-tar dyes exported include sulphur dyes, chiefly blacks and browns; direct cotton dyes, chiefly blacks, greens, blues, and reds; indigo (synthetic); acid dyes, chiefly scarlets and oranges; and basic dyes, chiefly malachite green, methyl violet, and magenta. The export trade in dyes is an important factor in producing dyes at a low cost to the domestic consumer. Germany, in order to minimize her costs of production, made every effort to develop and dominate foreign markets.

Part II.—CENSUS OF DYES AND COAL-TAR CHEMICALS, 1919.

CRUDES.

Introductory.—The production of coal-tar crudes by distillers of coal tar, crude light oils, and drip and holder oils is shown in Table 2. Those firms engaged primarily in the operation of coke ovens and gas houses, and operating distilleries for the production of crudes, reported their output to the Geological Survey. Unfortunately the production of crudes by these firms has not yet been tabulated, and complete figures on the production of coal-tar crudes during 1919 are therefore not available. It should be remembered that the figures for individual commodities in Table 2 represent only a part (in some cases a small fraction) of the total quantity of crudes available to the dye industry in 1919. These figures must be considered in connection with those for crudes at by-product coke ovens and gas houses, to be published at a later date by the United States Geological Survey.

There are, however, available facts showing that there exists, so far as crude materials are concerned (anthracene excepted), an adequate supply for the future growth and development of the coal-tar chemical industry in the United States. For example, the Geological Survey has reported that the productive capacity of the by-product coke ovens during 1919 increased 17.2 per cent over that of 1918. During the war the military demand for the by-products of coal distillation, especially toluene and ammonia, caused the War Industries Board and the War Department to aid in the erection of by-product coke ovens. The completion of many of these ovens during 1919 is responsible for this increase in productive capacity.

During 1919 the output of coke decreased sharply as compared with 1918 because of strikes in the steel and coal industries. But the reduction was almost entirely accounted for by the output of the wasteful beehive ovens. The production of coke in by-product ovens in 1919 was only 3.2 per cent less than in 1918. As a result the out-

put of coke from by-product ovens exceeded for the first time that the beehive ovens, which do not recover the valuable by-prod... It would appear, therefore, that there was only a slight decrea... the quantity of coal tar available during 1919. Transportation d... culties interfered with shipments of coal tar to distillers. Th... reflected by decreases in output as shown in Table 3. Shortag... coal due to strikes in coal mines also caused considerable quan... of tar to be burned as fuel. These factors resulted in less tar b... distilled. In general the conclusion may be drawn that there ... a reduction in the output of crudes in 1919.

TABLE 2.—*Production of coal-tar crudes during 1919, by firms not primar... gaged in the operation of coke-oven plants and gas houses.*

The numbers in the second column refer to the numbered alphabetical list of manufacturers giver... An x indicates that the corresponding product was made by a manufacturer who did not con... publication of his name in connection therewith. Blanks in the third and fourth columns indi... there was actual production of the corresponding article but that the figures can not be published revealing the output of individual firms.]

Name.	Manufacturers' identification No.	1919	
		Quantity.	Value.
Total crudes [a]			$17,657,7...
Benzene.....gallons	15, 16, 41, 53, 110, x, x	1,828,373	569,547
Toluene.....do	15, 16, 53	510,957	235,321
Xylene.....do	15, 53		
Naphthalene, crude.....pounds	12, 15, 16, 28, 91, 97, 115, 136, x	12,612,203	327,2...
Anthracene, less than 25 per cent pure	15, 136		
Carbazol	x		
Cresol	15, 30		
Pyridine	15, 111		
Solvent naphtha	15, 53, 136, x	266,013	78,817
Dead or creosote oil.....gallons	12, 15, 16, 28, 30, 46, 53, 67, 83, 91, 97, 110, 115, 129, 136, 164, x, x, x.	43,434,059	4,264,594
Anthracene oil	91, 136, x		
Pitch of tar.....short tons	15, 16, 25, 28, 30, 46, 53, 67, 83, 97, 110, 115, 120, 136, 170, x, x, x.	283,066	3,619,3...
Other distillates.....gallons	15, 16, 25, 28, 41, 46, 83, 97, 115, 136, 164, x.	6,867,001	1,461,50...
Refined tar.....barrels	15, 25, 28, 30, 53, 83, 97, 115, 136, x, x, x.	1,384,047	6,540,77...

[a] The instructions sent to manufacturers were as follows:

Include under "dead or creosote oil" only products which may be used for creosoting. Include "other distillates" shingle stain oils, disinfectant oils, and flotation oils which do not contain ... cent of phenol. Include under "refined tars" those tars which are used for road treatment, ... felt, and for protective coatings.

Phenol and all distillates which, on being subjected to distillation, yield in the portion distilli... 200° C. a quantity of tar acids equal to or more than 5 per cent of the original distillate, are not to be ... here but are to be placed in Group II.

Cresol, for the purpose of the schedule, is defined as a distillate, containing not more than 5 per ... phenol and at least 50 per cent of the isomeric cresols.

[1] The following table shows the fraction of the United States output of coke pro... in by-product ovens, as compiled by the Geological Survey:

1890	0	1916	...
1900	5.3	1917	...
1905	10.7	1918	...
1910	17.1	1919	...
1915	33.8		

TABLE 3.—*Comparison of production of coal-tar crudes, 1918 and 1919, by firms not primarily engaged in the operation of coke-oven plants and gas houses.*

Name.	1918			1919		
	Quantity.	Value.	Value per unit.	Quantity.	Value.	Value per unit.
Total crudes		$22,474,075			$17,657,750	
Benzene, gallons	3,015,848	994,161	$0.33	1,826,373	560,547	$0.31
Toluene, gallons	1,596,353	3,044,980	1.91	510,957	235,321	.46
Naphthalene, crude, pounds	40,138,092	1,281,440	.03	12,612,203	327,201	.03
Solvent naphtha, gallons	772,489	164,068	.21	266,013	78,817	.30
Dead or creosote oil, gallons	44,712,012	4,428,046	.10	43,434,059	4,264,594	.10
Pitch of tar, short tons	356,612	3,966,341	11.12	283,086	3,619,339	12.79
Other distillates, gallons	7,084,204	1,460,363	.21	6,867,001	1,461,500	.21
Refined tar, barrels	1,398,049	6,227,748	4.45	1,384,047	6,549,778	4.73

Shortage of naphthalene.—The output of crude naphthalene by tar distillers during 1919 was 12,612,203 pounds valued at $327,201, as compared with 40,138,092 pounds valued at $1,281,440 in 1918 by the same group of manufacturers. (These figures are not total output, as previously explained.) This large reduction in output by tar distillers was due to several causes, among which was the decreased distillation of tar. At the time of the signing of the armistice there were on hand large stocks of crude naphthalene which had accumulated as a by-product in the effort to secure maximum supplies of toluene for making explosives. As a consequence, producers of crude naphthalene expected an oversupply and therefore diminished their production by leaving considerable naphthalene in the creosote oil, thereby increasing the yield of creosote oil then in great demand. When export restrictions on dyes were removed there developed an unexpectedly large export demand for dyes and intermediates made from naphthalene. This quickly exhausted the accumulated stocks and resulted in an acute shortage of naphthalene toward the end of 1919 and in the early part of 1920. Imports of crude naphthalene from England during 1919 were not as large as was anticipated, owing to English export restrictions and transportation difficulties. During the first nine months of 1920, however, imports of naphthalene amounted to nearly 11,000,000 pounds.

The anthracene situation.—Considerable progress was made during 1919 in the production of anthracene, but the problem of securing adequate supplies is still unsolved. In 1918 the actual anthracene contained in the crude anthracene produced was about a quarter of a million pounds, but very little of the crude product was refined. In 1919 the output of actual anthracene was about three times the 1918 production, and a much larger fraction of it was refined than in 1918. Notwithstanding this encouraging progress a much greater increase in output must be secured before there will be enough

anthracene available from domestic sources to supply the demand for alizarin and vat dyes which are so important to a well-developed industry. It may be roughly estimated that the 1919 production of crude anthracene contained less than one-fifth of the amount of anthracene required for domestic needs. The fundamental difficulty is not primarily an actual lack of anthracene in the tar, nor are there purely technical difficulties in its recovery, but rather the fact that its removal leaves the pitch so hard that it does not find a ready market in this country. Any method of recovering anthracene which seriously disturbs the marketing of the other larger fractions of the tar, especially the pitch, would make the anthracene so expensive that the dyes derived therefrom could not be made on a competitive basis. In England and Germany large amounts of hard pitch were used for the briquetting of coal dust and coke breeze, but this industry is little developed in the United States. England shipped considerable amounts of crude anthracene to Germany before the war.

The securing of supplies of anthracene adequate in amount and at a cost which is not prohibitive is perhaps the greatest difficulty confronting the industry. Whether the problem will be solved by the tar distillers or by the development of a synthetic process for making anthraquinone (the most important intermediate made from anthracene) from raw materials now available in adequate quantity can not be determined at the present time. Active work along both lines is well under way and important progress has been made during 1920.

Production of carbazol was reported in 1919 by one firm. It is obtained as a joint product in the separation of anthracene from coal tar. The development of a demand for carbazol would facilitate an increase in the production of anthracene from coal tar.

INTERMEDIATES.

Introductory.—The production of intermediates in the United States during 1919 is shown in Table 4 in as great detail as possible without revealing the output of individual manufacturers. During 1919 there was produced a total of 177,362,426 pounds of intermediates, valued at $63,210,079—a decrease of about 50 per cent from the output in 1918 of 357,662,251 pounds, valued at $124,382,892. Notwithstanding this large decrease in quantity the number of individual intermediates produced in 1919 was 216, as compared with 140 in 1918. The 1919 output, with the exception of many of the anthracene derivatives which are still not produced, more nearly represents domestic requirements under peace-time conditions. In addition to these intermediates, there were produced on a laboratory scale 119 intermediates or organic coal-tar chemicals for research and

xperimental purposes. These totaled 2,291 pounds and were valued t $23,333, as compared with an output in 1918 of 645 pounds, valued t $7,843.

Intermediates used for military purposes.—The decrease in quanity of intermediates can be traced directly to the cessation of military requirements. There was a marked decrease in those intermediates used in making explosives and in those required for dyes for military uniforms. If the intermediates used mainly for explosives be eliminated from consideration, the remaining ones show an increase in output of about 10 per cent during 1919 as against the corresponding intermediates in 1918. The most striking example of a decrease in intermediates used for explosives is phenol.

The enormous output of phenol (106,794,277 pounds) in 1918, made almost entirely in synthetic phenol plants, left large stocks of this product on hand when the armistice was signed. Consequently, the price of phenol declined sharply—from about 45 cents per pound to 5 cents—but soon rose again to about 15 cents per pound. The surplus stock of Government phenol on hand at the signing of the armistice, about 35,000,000 pounds, represented nearly three times the normal annual consumption. The Monsanto Chemical Co., of St. Louis, Mo., was made the agent of the War Department for its sale. The synthetic phenol plants responsible for the huge output shut down promptly after the signing of the armistice, and many of them were later entirely dismantled. It is probable, however, that the present and future consumption of phenol will be in excess of the output of natural phenol obtained by separation from coal-tar distillates, and that when the surplus stocks have been consumed some of the synthetic plants will necessarily resume production.

Other intermediates used both for war purposes and for dye manufacture which showed a striking decrease in 1919 include monochlorobenzene, with a decrease of 80 per cent; nitronaphthalene, 36 per cent; dimethylaniline, 16.5 per cent; diphenylamine, and dinitrotoluene. It is probable that the production of all of these in 1919 was below the amount used during the year for dye making, and that stocks on hand November 11, 1918, and intended for military uses were diverted to the dye industry. It may therefore be assumed that the production of these intermediates during 1919 was somewhat less than actual requirements.

Intermediates required in the manufacture of dyes used for military uniforms also showed a decrease corresponding to the decreased output of such dyes. Among these may be mentioned: m-dinitrobenzene and m-nitraniline which are used in Alizarin Yellow GG and R—dyes used on wool cloths for army uniforms—and m-toluylenediamine, used for sulphur browns on cotton cloths for khaki uniforms.

Intermediates consumed in large quantity.—As a rule the intermediates for which there is the largest normal consumption and the manufacture of which had been well established by 1918, showed comparatively little change during 1919. Examples of these are nitrobenzene, aniline, paranitraniline, and betanaphthol. On the other hand, there are also many examples of a large increase in the production of intermediates difficult to make but which are required for dyes of the best quality. A good example of this kind is amidonaphthol sulphonic acid 2:8:6 (gamma acid). This was made in 1918 by a single firm, but in 1919 by five firms, with a combined output of 155,025 pounds, valued at $667,360, which is many times the 1918 output. These five firms used gamma acid to make nearly a half million pounds of Oxamine Black—an important direct black which can be developed on the fiber. Moreover, gamma acid is also required for other important direct cotton dyes of a fast type, and in the manufacture of Zambesi Black, a very important dye for misc. hosiery.

Toluene derivatives.—There was a notable increase in output and a marked decrease in price of those intermediates derived from toluene. Benzoic acid, U. S. P., for example, increased in output from 172,896 pounds in 1918 to 699,108 pounds in 1919, and the price dropped from $3.07 to $0.77 per pound. Orthotoluidine and paratoluidine, important intermediates, doubled in output with about a 50 per cent reduction in value. The general increase in output of toluene derivatives and the decrease in value are due to removal of war-time restrictions on toluene and the lessened demand for it.

Intermediates derived from anthracene.—During 1919 the actual anthracene content of the anthracene produced amounted to 813,318 pounds, or over three times the output in 1918. In 1919 three firms, as against only one firm in 1918, reported a production of refined anthracene of more than 80 per cent purity suitable for the manufacture of vat and alizarin dyes. The total quantity of refined anthracene produced was several times the output of the previous year. It may be roughly estimated that over 4,000,000 pounds of pure anthracene would be required to manufacture alizarin and vat dyes to the amount of the average annual import from 1912 to 1914, inclusive.

The progress among the anthracene derivatives is of especial interest. Here, unfortunately, definite figures can not be given without revealing the production of individual firms. In 1919 there were 10 intermediates produced from anthracene, as against only 5 in 1918. The output of anthraquinone, which is the most important because it serves as the raw material for the manufacture of nearly all other intermediates derived from anthracene, was about ten times as great in 1919 as in 1918. Recent information indicates that several firms

are experimenting on the production of anthraquinone synthetically from benzene and phthalic anhydride. One firm is now (December, 1920) known to be manufacturing synthetic anthraquinone in commercial quantities. The production of anthraquinone in adequate quantity either from natural anthracene or synthetically from other coal-tar materials already available will mean much to the future development of a well-rounded and permanent dye industry in the United States.

TABLE 4.—*Production of intermediates during 1919.*

[The intermediates are arranged in this table according to chemical structure. They are listed under the following five classes: Benzene compounds; toluene compounds; xylene compounds; naphthalene compounds; and anthracene compounds. Each class of compounds is further divided into 10 numbered subclasses, based on the following arbitrary order: (1) Halogen, (2) nitro, (3) amino, (4) sulphonic acid, (5) hydroxyl, (6) alcohols, (7) aldehydes, (8) carboxylic acids, (9) ketones, and (10) all others. If a compound contains two or more radicals, it is arbitrarily classed under the subclass of the highest numerical order. For example, the compound nitrophenolsulphonic acid is listed under the benzene compounds, subclass (5), hydroxyl, since the hydroxyl radical is of higher numerical order than the (2) nitro and (4) sulphonic radicals. The numbers in the second column refer to the numbered alphabetical list of manufacturers printed on p. 94. An x signifies that the corresponding intermediates were made by a manufacturer who did not consent to the publication of his name in connection therewith. Blanks in the third and fourth columns indicate that there was actual production of the corresponding intermediates in the United States during 1919, but that the figures can not be published without revealing information in regard to the output of individual firms. The details thus concealed are, however, included in the totals. Reports have been received from all firms known to be manufacturers.]

Common name.	Manufacturers' identification numbers according to list on page 94.	Total production, 1919.		Average price per pound.
		Quantity.	Value.	
		Pounds.		
Total intermediates		177,862,426	$63,210,079	$0.36
BENZENE COMPOUNDS.				
Halogen:				
Chlorobenzene (mono)	53, 64, 76, 92, 118, 132, 151	4,116,606	623,875	.15
p-Dichlorobenzene	76, 118, 132	130,864	8,746	.07
Bromobenzene (mono)	52			
Nitro:				
Nitrobenzene (oil of myrbane)	16, 24, 27, 53, 64, 104, 112, 113, 116, 151, x, x, x, x.	42,544,017	5,899,837	.14
Nitrochlorobenzene (ortho and para)	13, 53, 109, 112, 136, x	2,520,991	789,117	.29
p-Dichloronitrobenzene	116			
Dinitrobenzene	23, 24, 53, 66, 112, 116, 156, x	2,290,282	548,302	.24
Dinitrochlorobenzene	13, 53, 64, 92, 109, 151, 166	4,428,730	937,794	.21
Amino:				
Aniline oil	16, 24, 27, 53, 64, 66, 104, 109, 112, 113, 151, x, x, x.	24,345,786	5,932,536	.24
Aniline salt (and sulphate)	24, 27, 66, 112, 113	1,446,909	359,296	.25
Aniline for red	112			
Dimethylaniline	24, 53, 112	3,559,654	1,941,152	.55
Ethylaniline (mono)	31, 53, 112	195,161	305,526	1.57
Diethylaniline	31, 74, 143	30,000	26,500	.88
Ethylbenzylaniline	31, 53, 112			
Dibenzylaniline	112			
Nitrosodimethylaniline	8, 40, 53, 64, 66, 68, 92, 112, x	592,663	364,091	.61
Acetanilide, technical	23, 31, 53, 64, 109, 112, 116, 136, x, x.	1,934,125	797,151	.41
p-Nitroacetanilide	23, 116, 136, x	699,658	484,996	.69
Ethylacetanilide	112			
Gallanilide	112			
p-Chloroaniline	x			
Dichloroaniline	116			
m-Nitraniline	53, 156, x	68,609	104,322	1.52
p-Nitraniline and sulphate	23, 53, 92, 112, 116, 136, x, x	1,310,658	1,388,627	1.06
m-Phenylenediamine	5, 8, 23, 53, 58, 64, 99, 112, 116, 156, x, x.	609,789	617,379	1.01
p-Phenylenediamine	16, 64, 112, 136, 146, 171, x, x	234,332	568,396	2.43
Acet-p-phenylenediamine	23, 112, 116, 136, x	62,567	103,730	1.66
Diphenylamine	112, x			
Phenazine	92			
Phenylglycine, sodium salt	112			

TABLE 4.—*Production of intermediates during 1919*—Continued.

Common name.	Manufacturers' identification numbers according to list on page 94.	Total production, 1919.		Average price per pound
		Quantity.	Value.	
BENZENE COMPOUNDS—Con.				
		Pounds.		
Sulphonic acid:				
Sulphanilic acid	24, 27, 53, 66, 69, 92, 101, 112, 156, x, x.	1,023,861	$243,656	$0.24
Metanilic acid	53, 54, 64, 112, x	453,137	266,172	.59
o-Chlorometanilic acid	136			
p-Chlorometanilic acid	136			
Nitrobenzenesulphonic acid	136			
Ethylbenzylaniline sulphonic acid	31			
Ethylbenzylanilinedisulphonic acid	116			
Dinitrophenol sulphonic acid	23			
Dinitrochlorobenzene sulphonic acid	23			
Amino-azo-benzene and sulphonate.	27, 54, 69, 92, 112, x	82,755	59,847	.72
Hydroxyl:				
Phenol (U. S. P. and tech.)	15, 24, 30, 41, 101, 134	1,543,659	155,624	.10
Nitrophenol	116			
o-Nitrophenol	8, 23, 116, 156	18,373	16,497	.90
p-Nitrophenol	8, 13, 23, 53, 66, 109, 116, 151, 156	76,191	76,464	1.00
Nitro sodium phenolate	53, 57			
Dinitrophenol, and sodium salt	13, 53, 64, 112	230,771	65,050	.28
Nitroaminophenol 1:2:4	64			
Indophenol	13, 45, 92, 112, x	130,001	131,229	1.01
o-Nitroanisol	112, 116, x			
o-Anisidin	116			
o-Amidophenol	8, 112			
Diethyl m-amidophenol	53			
p-Amidophenol and sulphate	16, 19, 24, 53, 57, 64, 89, 92, 104, 145, x.	128,627	282,970	2.20
o-Amidophenol p-sulphonic acid	23, 112			
Nitroamidophenol sulphonic acid	23			
Diamidophenol	163			
Nitrosophenol	13, 40, 45, 92, 112, 116, x	155,273	82,833	.53
Nitrophenetol (ortho and para)	53			
p-Phenetidin	109			
Picric acid	23			
Ammonium picrate	23			
Picramic acid	23, 24, 53, 112, x	150,458	130,388	.87
Resorcin (tech. and U. S. P.)	66, 112, x	96,397	402,491	4.20
Alcohols:				
Benzyl alcohol	61, 65, 66, 141, 155, x, x	15,678	33,770	2.15
Aldehydes:				
Benzaldehyde	20, 24, 31, 37, 53, 61, 65, 134, 141, 155, x, x.	518,634	403,109	.78
Chlorobenzaldehyde	112			
Nitrobenzaldehyde	112			
Carboxylic acids:				
Benzoic, tech	53, 61, 65, 135, 155	21,212	46,354	2.19
Benzoic, U. S. P	20, 53, 77, 134, 135, 141, x	699,108	534,832	.77
Ammonium benzoate	51			
Sodium benzoate	20, 76, 77, 135, x, x	610,150	536,194	.88
Nitrobenzoic acid	x			
o-Amido benzoic (anthranilic)	109, 136, 150, 168, x, x	22,976	98,602	4.29
Acet. anthranilic acid	136			
Salicylic, tech	23, 24, 53, 104, 109, 134, x, x, x	3,467,055	1,009,462	.29
Salicylic, U. S. P	20, 24, 44, 52, 53, 104, 109, x, x, x.	2,619,726	918,832	.35
Amidosalicylic acid	24, 92, 112	37,769	44,144	1.17
Cinnamic acid	61, 141, x	2,502	10,305	4.12
Ethyl p-aminobenzoate (not medicinal).	x			
o-Sulphobenzoic and ammonium salt.	81			
Chloride of o-sulphobenzoic acid	81			
Ketones:				
Tetramethyldiaminobenzophenone (Michler's ketone).	23, 53, 64	281,057	488,553	1.74
Diphenyls:				
Benzidin base	5, 23, 31, 53, 66, 112, 116, x	1,084,922	1,370,393	1.26
Benzidin sulphate	3, 23, 31, 53, 112, x, x	234,707	224,283	.96
o-Nitrobenzidin and sulphate	68, 116			
Dinitrooxydiphenylamine	116			
Dianisidin	53, 112, 116	107,441	488,114	4.54
Diphenylmethane	112			
Other benzene compounds:				
Thiocarbanilide	112, 113, 134, x, x, x	2,268,375	802,575	.35
Arsanilic acid	103			
Oxarylphenylarsenic acid	47, 103, x	6,944	117,288	16.89
Nitrophenolarsenic acid	47, 103, x	3,341	147,023	44.03

TABLE 4.—*Production of intermediates during 1919*—Continued.

Common name.	Manufacturers' identification numbers according to list on page 94.	Total production, 1919.		Average price per pound.
		Quantity.	Value.	
TOLUENE COMPOUNDS.				
		Pounds.		
Halogen:				
Chlorotoluene	112			
Benzylchloride	20, 23, 31, 61, 65, 134, 141, 155	720,953	$166,182	$0.23
Benzalchloride	61, 65, 141, x			
Benzoylchloride	61, 65			
Nitro:				
Nitrotoluene	31, 53, 54, 62, 112, 116, 147, x, x	6,211,775	1,049,522	.17
o-Nitrotoluene	53, 112, 116, x	1,360,599	312,416	.23
m-Nitrotoluene	53, 69			
p-Nitrotoluene	31, 53, 62, 112, 116, 147, x	1,263,056	704,750	.56
Dinitrotoluene	31, 53, 54, 64, 69, 112, 116, x	746,266	264,388	.35
Chloronitrotoluene	x			
Amino:				
Toluidine	31, 53, 112, 147, x, x	806,210	309,894	.38
o-Toluidine	53, 66, 112, 116, 147, x	1,002,982	503,020	.50
p-Toluidine	53, 62, 66, 112, 116, 147, x	575,841	600,267	1.04
Methylorthotoluidine	92			
o-Chlor p-toluidine	x			
o-Acetotoluidine	136			
p-Acetotoluidine	136, x			
o and p-Nitrotoluidine	147, x			
m-Nitroparatoluidine	53, 136, x, x	58,454	210,307	3.60
m-Toluylenediamine	31, 53, 54, 64, 69, 112, 116	439,544	504,063	1.15
Tolidine	53, 66, 112, 116, x	143,012	264,861	1.86
Tolidine sulphate	116			
Sulphonic acid:				
o-Chlorotoluene sodium sulphonate	109			
p-Nitrotoluene sulphonic acid	53, 112, x	32,338	29,464	.91
o-Toluidine sulphonic acid	69			
p-Toluidine sulphonic acid	1, x			
o-Chloro p-toluidine m-disulphonic acid.	x			
Toluylenediamine sulphonic acid	112			
o-Toluene sulphochloride	26, 109			
p-Toluene sulphochloride	26, 109, x	58,932	6,148	.10
o-Toluene sulphamide	26, 109, x			
p-Toluene sulphamide	26, 109			
Hydroxyl:				
Refined cresol	116			
Creosote oil (containing more than 5 per cent tar acids).	x			
Stilbenes:				
Dinitrostilbene disulphonic	112			
Diamidostilbene disulphonic acid	112, x, x	5,021	19,082	3.80
Other toluene compounds:				
Amino-azo-toluol	64, 69, x	4,836	7,871	1.63
Hydrazotoluol	112			
Dehydrothio-para-toluidine sulphonic acid.	18, 54, x, x			
XYLENE COMPOUNDS.				
Nitroxylol	27, 112, x, x	293,219	53,449	.18
Xylidine	5, 24, 27, 53, 112, 147, x, x	386,635	206,797	.53
Xylidine salts	24, x			
Dehydrothio m-xylidine base	68, x			
Cumidine	112, x			
NAPHTHALENE COMPOUNDS.				
Naphthalene, solidifying 79° C. or above (refined, flake).	15, 30, 53, 91, 97, 134, 164	17,625,235	1,160,815	.07
Halogen:				
Chloronaphthalene	39			
Nitro:				
Nitronaphthalene	15, 53, 116, x	2,774,516	368,500	.13
Dinitronaphthalene	112			
Amino:				
a-Naphthylamine	15, 53, 116, x	1,552,828	632,587	.41
Phenylalphanaphthylamine	23, 53			
b-Naphthylamine, crude	53, 124, x	99,597	167,590	1.68
Ethylbetanaphthylamine	x			

TABLE 4.—*Production of intermediates during 1918—Continued.*

TABLE 4.—*Production of intermediates during 1919*—Continued.

Common name.	Manufacturers' identification numbers according to list on page 94.	Total production, 1919. Quantity.	Total production, 1919. Value.	Average price per pound.
NAPHTHALENE COMPOUNDS—Continued.				
Other naphthols:		*Pounds.*		
Amidonaphthol sulphonic acid 1:2:4.	23, 27, 53, 54, 64, 92, 112, 136, 152, x, x, x.	837,384	$808,894	$0.97
Amidonaphthol sulphonic acid 2:8:6 (gamma acid).	5, 53, 92, 112, 116	155,025	667,360	4.30
Amidonaphthol disulphonic acid 1:8:2:4 (Chicago acid).	53, 116			
Amidonaphthol disulphonic acid 1:8:3:6 (H acid).	53, 64, 105, 108, 112, 116, 152, 163, x, x, x.	3,837,534	5,081,460	1.32
Chloronaphthol disulphonic acid 1:8:3:6 (chlor H acid).	112			
Diazonaphthol sulphonic acid 1:2:4.	23, 92, 112	419,349	417,815	1.00
Nitrodiazo naphthol sulphonic acid 8:1:2:4.	23			
Carboxylic acids:				
Hydroxy naphthoic acid 2-3	x			
Other naphthalene compounds:				
Phthalic anhydride	23, 66, 109, 162, 168, x	290,677	290,087	.99
Phthalamide	159, x			
o-Cresolphthalein	81			
o-Cresolsulphophthalein	81			
Dibromcresolsulphophthalein	81			
Dibromsulphophthalein	81			
Tetrabromphenolsulphophthalein	81			
Thymolsulphophthalein	81			
ANTHRACENE COMPOUNDS.				
Anthracene, purity of 25 per cent or more.	11, 15, 91, 112, x	1,381,944	298,977	.22
Anthraquinones:				
Anthraquinone	2, 11, 53, 112	294,269	547,787	1.86
Dinitroanthraquinone	112			
Betaaminoanthraquinone	53			
Anthraquinone 2 sodium sulphonate (silver salt).	53, 112			
Anthraquinonedisulphonate 1:5	112			
Anthraquinone disulphonic acid 2:7.	112			
Dihydroxy anthraquinone 1:5 anthrarufin.	112			
Nitrosulfoanthrarufin	112			
Benzanthrone	53			
Chlorobenzanthrone	53			
CARBAZOL COMPOUNDS.				
Carbazol, purity of 25 per cent or more	15, 53			
All other intermediates	23, 112, 116, x, x			

CHEMICALS FOR SALE FOR RESEARCH AND EXPERIMENTAL PURPOSES.

Total		*Pounds.* 2,291	$23,333	$10.18
BENZENE COMPOUNDS.				
Halogen:				
Iodobenzene	57, 153			
o-Dichlorobenzene	57			
Amino and related derivatives:				
Aniline redistilled	x			
p-Bromoaniline	57			
p-Chloroaniline	57-153			
o-Chloroaniline	153			
p-Bromoaniline hydrochloride	57			
Dichloroaniline 2:4	57			
Methylaniline	57			
p-Bromoacetanilide	57			
Methylacetanilide	57			
p-Nitroethylacetanilide	57			
p-Aminodimethylaniline hydrochloride	57			
Benzylamine	158			
Phenylhydrazine	57-66-x			

TABLE 4.—*Production of intermediates during 1919*—Continued.

Name.	Manufacturers' identification numbers according to list on page 94.	Total production, 1919.		Average price per pound.
		Quantity.	Value.	
BENZENE COMPOUNDS—Con.				
Other benzene compounds—Continued.				
Phthalimide	57			
Benzonitrile	57			
Benzyl cyanide	57			
Phenyl isocyanate	153			
Thiophenol	153			
Potassium hydrogen phthalol	57			
Quinone	57			
Chloroanil	57			
Quinhydrone	57			
a-Benzildioxime	57			
Ethylphenylacetate	153			
Diphenylpiperazine	57			
Diphenylpiperazine hydrochloride	57			
p-Dimethylaminoazobenzene	57			
TOLUENE COMPOUNDS.				
Halogen:				
o-Bromotoluene	153			
p-Bromotoluene	153			
o-Iodotoluene	153			
Amino:				
Acetyl p-toluidine	57			
Benzoyl o-toluidine	57			
Sulphonic acid:				
Aminotoluene sulphonic acid 4:2	57			
p-Toluenesulphonyl hydrochloride	57			
Phenyl p-toluenesulphonate	57			
p-Toluenesulphonylaniline	57			
p-Toluenesulphonyl methylaniline	57			
Hydroxyl:				
o-Cresol p-toluenesulfonate	57			
o-Cresol methyl ether	57			
Butyl o-cresol ether	57			
p-Thiocresol	57, 153			
XYLENE COMPOUNDS.				
o-Xylene	57			
m-Xylene	57			
p-Xylene	57			
o-Xylene sodium sulphonate	57			
p-Xylene sodium sulphonate	57			
Mesitylene	153			
NAPHTHALENE COMPOUNDS.				
Halogen:				
Alpha bromonaphthalene	57, x			
Benzoyl a-naphthylamine	57			
Hydroxyl:				
Nitroso b-naphthol	57, x			
QUINOLINE COMPOUNDS.				
Quinoline	57			
Quinoline ethiodide	57			
Quinaldine	57, 153			
b-Naphthaquinaldine	57			

TABLE 5.—*Production of intermediates, 1918 and 1919*—Continued.

Name.	Production, 1918.			Production, 1919.		
	Quantity.	Value.	Price per pound.	Quantity.	Value.	Price per pound.
NAPHTHALENE COMPOUNDS.						
Naphthalene, solidifying 79° C. or above (refined, flake)	*Pounds.* 28,112,165	$2,162,618	$0.08	*Pounds.* 17,625,235	$1,160,815	$0.066
Nitro:						
Nitronaphthalene	4,340,019	1,439,052	.33	2,774,516	368,500	.133
Amino:						
a-Naphthylamine	2,671,601	1,327,740	.50	1,552,828	632,587	.407
b-Naphthylamine, crude	31,317	45,747	1.46	99,507	167,589	1.683
Sulphonic acids:						
Sulpho(alpha)amino compounds—						
Naphthylamine sulphonic 1:4 (Naphthionic)	1,462,261	959,291	.66	2,008,189	1,235,742	.615
Hydroxyl:						
Alpha naphthol compounds—						
a-Naphthol	136,723	102,032	.75	135,025	136,883	1.013
Alpha naphthol sulphonic acids—						
Naphthol sulphonic 1:4 (Neville & Winthers)	340,074	421,589	1.24	344,449	629,857	1.829
Beta naphthol compounds—						
b-Naphthol, tech	5,117,683	3,009,773	.59	4,835,778	2,365,801	.488
Beta naphthol sulphonic acids—						
Naphthol sulphonic 2:6 [a]	169,383	127,693	.76	146,111	102,975	.705
Naphthol disulphonic 2:3:6 (R acid)	712,033	572,401	.80	1,008,007	721,341	.716
Other naphthols:						
Amido naphthol sulphonic acid 1:2:4	109,999	210,478	1.84	837,384	808,891	.966
Amido naphthol disulphonic acid 1:8:3:6 (H acid)	2,883,228	4,879,351	1.69	3,837,534	5,081,469	1.324
Other naphthalene compounds:						
Phthalic anhydride	227,414	648,650	2.85	290,677	290,037	.997
ANTHRACENE COMPOUNDS.						
Anthracene, purity of 25 per cent or more	25,552	80,679	.36	1,381,944	298,977	.216

[a] 1918 figures include naphthol sulphonic 2:3.

INTERMEDIATES USED IN DYEING AND PRINTING.

In many cases the last chemical step in the manufacture of dyes can be advantageously performed on or within the fiber to be dyed rather than in a dye factory. In this way an insoluble dye can be precipitated within the fiber, and thus secure a high degree of fastness. As a consequence, textile mills and other dye consumers have been purchasers of intermediates. The German dye makers made a practice of selling intermediates for this purpose to textile mills under special trade names designed to conceal the chemical nature of the product. German firms were thus enabled in many cases to charge prices to the consumers above the market prices of the intermediates when sold under their true chemical names.

In Table 6 are given the trade names under which these products were sold by German firms before the war, with the corresponding scientific chemical names, the imports (when available) during the fiscal year 1914[1] and the American production during 1919. The

[1] Norton, Thomas H.: "Artificial Dyestuffs Used in the United States," Dept. of Commerce, Sp. Agents Series. No. 121; and Pickrell, Dr. E. R.: "Chemicals and Allied Products Used in the United States," Dept. of Commerce, Misc. Series No. 82.

identification, of course, can not be guaranteed since it has not been possible to make a critical laboratory examination of authentic samples. It is based upon a careful search of the scientific and technical literature and correspondence or consultation with a number of experts in this field. It is especially interesting to note the extent to which these needs are being met by American manufacturers of intermediates. It is hoped that the publication of this information will enable American consumers to purchase these materials under their own proper names at more reasonable prices, and will also help American intermediate makers to supply those not yet made in the United States.

TABLE 6.—*Intermediates used in dyeing and printing.*

Trade name.	Chemical name.	Imports, 1914 (Norton-Pickrell).	United States production, 1919.	Uses.
I. BENZENE DERIVATIVES.				
Developer J	Phenol	[1] 1,715,465 $109,146	[1] 1,543,659 $155,624	Developing direct dyes.
Yellow developer, Dye salt VII.				
Developer F, Dye salt VI.	Resorcin	[1] 61,624 $18,175	[1] 96,397 $402,491	Do.
Orange developer				
Para	Paranitraniline	[1] 771,682 $109,374	[1] 1,310,658 $1,388,627	For para reds and as a developer.
Azogen red	p-nitrodiazo benzene			Insoluble azo dyes.
Azophor red PN	p-nitrodiazo with stabilizer			
Benzonitriol	do			
P-nitraniline, extra paste N.	do			
Nitrazol C	do			
Nitrosamine red	Nitrosamine is the sodium compound of diazotized nitraniline.			
Parazol F. B				
Azophororange MN	Meta-nitraniline	[1] 15,527	[1] 68,600	Insoluble azo colors.
	Diazo compound of above.	$1,037	$104,322	Insoluble azo black.
Reserve salt O	m-Nitrobenzene sulphonic acid.		[2]	
	Aniline		[1] 24,345,786 $5,932,536	Oxidation black.
Azotol C, or Prague ice black.	A symmetrical dialkylated di-p-amidoazo-benzene or amido-chrysoidine.			Insoluble azo dyes. Gives black on b-naphthol prepared goods.
Developer A. D., fast blue developer A. D.	Amidodiphenylamine	[1] 100 $39		Developing direct colors.
Diphenyl, black base	P-amidodiphenylamine			For oxidation black.
Diphenyl black oil D. O.	P-amidodiphenylamine in aniline.			Do.
Developer H	M-phenylenediamine	[1] 58,978 $14,463	[1] 439,544 $804,063 [1] 609,789 $617,379	Developing direct colors.
Developer C for brown, Dye salt V.				
Oxamine dev. N. X				
"Paramine," Paramine Extra, B. A. S. F.	P-phenylenediamine	[1] 11,068 $3,414	[1] 234,332 $568,396	Oxidation brown.
Diamine B. B	A chlorinated diamine			Developing direct colors.
Nerogene D	Chloro-m-phenylenediamine.			
Developer N. B	Nitro-benzidin	o-Nitro-ben ..... 700 Benzidin 966		Do.
Solvenol, Solution Salt B, Solvenol O, Algosol.	Sodium-salt of benzyl sulphanlic acid.	[3] 4,000		Silk printing.
Fuscamine G	M-aminophenol			Oxidation brown.
II. TOLUENE DERIVATIVES.				
Diamine developer C; H (powder), E (solution).—Diamine B.	Meta toluylene diamine or meta phenylenediamine.	[1] 133,355 $25,582	[1] 439,544 $804,063	Developing direct dyes.

[1] Pounds.

[2] Produced during 1919, but figures not publishable.

[3] Pounds, estimated.

TABLE 6.—*Intermediates used in dyeing and printing*—Continued.

Trade name.	Chemical name.	Imports, 1914 (Norton-Pickrell).	United States production, 1919.	Uses.
II. TOLUZENE DERIVATIVES—continued.				
.....	Para toluidine.....	[1] 24,686 $4,764	[1] 575,841 $600,267	Insoluble azo colors.
Reserve salt W.....	p-Nitro-toluene sulphonic acid.	.....	[1] 32,338 $29,464	
Nitrotoluidine G..... Base HR, pigment fast red base HL..... Fast red G base..... Helio fast red base HL... Lithol fast scarlet RW base.	m-Nitro para toluidine.....	[1] 10,513 $4,200	[1] 58,454 $201,307	Do.
	o-Nitro p-toluidine.....	[1] 65,647 $17,814	[1] 24,125 $4,825	Do.
	p-Nitro o-toluidine.....	.....	[2]	Do.
Nitrosamine Rose B X; Azorosa N A, Nitroanisidine A; Tuscalin red base.	p-Nitro-o-anisidine.....	[3] 2,000	.....	Do.
Azophor Rose A, Naphthol Rosa.	diazo compound of above.	.....	.....	
Tuscalinorange base G...	m-Nitro-o-anisidine.....	.....	.....	Do.
Chloranisidine salt M, or chloranisidine P.	p-Chlor-m-anisidine.....	.....	.....	With B-naphthol gives scarlet red.
Azophorrose A.....	Stabilized diazo-o-anisol...	.....	.....	Insoluble azo dyes.
Blue red O.....	o-Nitro-p-phenetidine.....	.....	.....	For shading para red (bluish) shades.
.....	Benzidine.....	[1] 55,243 $16,991	[1] 1,084,922 $1,370,393	Insoluble azo colors.
.....	Toluidine.....	[1] 5,874 $3,763	[1] 806,210 $309,894	Do.
Azophor blue D.....	Tetrazo dianisol with stabilizer.	[1] 10,656 $4,217	.....	Insoluble azo colors, with copper salts to give blue.
Ortamin.....	o-Dianisidin.....	.....	[4] 107,441	Oxidation red brown.
III. XYLENE DERIVATIVES.				
.....	Xylidine.....	[1] 21,836 $2,657	[1] 386,635 $206,797	Insoluble azo colors.
.....	Cumidine.....	[1] 6,617 $1,169	[1] 16,910 $36,226	Do.
IV. NAPHTHALENE DERIVATIVES.				
Maroon developer.....	Alpha-naphthol.....	[1] 403,317 $53,600	[1] 135,075 $136,937	Developing direct dyes.
Crimson developer.....	Alpha-naphthol p-sulphonic acid.	.....	[1] 344,449 $629,857	
Developer A (Sodium salt) for red or Dye salt II.	B-naphthol.....	[1] 1,233,458 $112,007	[1] 4,825,668 $2,356,230	
Naphthol D.....	B-oxy-naphthoic acid.....	[1] 2,647 $1,029	[2]	Para red.
Naphthol AS.....	B-oxy-naphthoic anilide...	[1] 1,997 $1,218	.....	Insoluble azo dyes.
Naphthol AC.....	B-oxy-naphthoic toluide or aniside, phenetide, xylide.	.....	.....	Do.
Shading salt, "Mono acid." "Facid."	B-naphthol sulphonic acid F (2:7).	[1] 21,253 $5,563	[1] 23,156 $51,181	For para reds.
Naphthol R.....	B-naphthol 90 per cent and B-naphthol monosulphonic acid F.	.....	.....	Para red bluish shade.
B-naphthol DC.....	Molecular mixture—B-naphthol, B-oxy-naphthoic acid, B-naphthol sulpho acid E, or dioxy-naphthalin 2:3, 2:6, or 2:7.	.....	.....	Insoluble azo dyes.
Developer ES.....	2:3 dioxy-naphthalene-sulphonic acid.	.....	.....	Developing direct colors.
Developer G..... Blue developer AN.....	Amidonaphthol sulphonic acid (1:2:4?).	[1] 1,153 $445	[1] 837,384 [5] $808,894	Developing direct dyes.
Developer E for brown... Gambea R.....	Nitroso B-naphthol.....	.....	[1] 24,777 $11,877	
Paradurol.....	Naphthalene trisulphonic acid.	.....	[3]	Organic stabilizer in production of para reds.

[1] Pounds.
[2] Actual production during 1919 but figures not publishable.
[3] Estimated pounds.
[4] "Dianisidin."
[5] 1:2:4.

TABLE 6.—*Intermediates used in dyeing and printing*—Continued.

Trade name.	Chemical name.	Imports, 1914 (Norton-Pickrell).	United States production, 1919.	Uses.
IV. NAPTHALENE DERIVATIVES—contd.				
Amidonaphthol 3 D and 3 B.	Amido naphthol 1:6 or 1:7.	.....	.....	Insoluble azo dyes.
Naphthylamine	A naphthylamine	[1] 112,226 $10,620	[1] 1,552,828 $632,587	Insoluble azo colors.
	"Sulphate"	[1] 610 $318		
.....	B naphthylamine	[1] 10,698 $3,404	[1] 99,597 $167,590	Do.
Developer B for Bordeaux claret dev. B. dev.	Ethyl B naphthylamine	[1] 3,282 $1,749	[1] 140 $705	Developing direct dyes.
V. MISCELLANEOUS.				
Nighrophor, B. A. S. F.	Sodium, salt of p-nitro benzene, 5 sulpho, 1 amido, 8 naphthol azo, 2:5 dichlobenzene.	.....	.....	Insoluble azo black.
Nigrogen	1:8 naphthylen diamine 4-sulphonic acid and acetone.	.....	.....	Insoluble azo black.
Asophor black S	Mixture of tetrazo-dianisol with other diazo compounds as m-nitranilin, etc.	.....	.....	Do.
Naphthylamine ether	Amidonaphthol ether	.....	.....	Developing direct dyes.
Developer Z	Phenyl methyl pyrazolone	[1] 1,397 $377	.....	Do.
Solidogen	Formaldehyde condensed p and o toluidine.	.....	.....	Developing direct colors.
Para brown salt G	The dye "Vesuvine"	[1] 27,576 $5,352	[1] 412,574 $417,276	Insoluble azo brown with p-nitraniline.
Para brown salt R	The dye "Chrysoidine"	[1] 105,946 $16,852	[1] 220,542 $246,977	
Leucotrop	Dimethyl phenyl benzyl-ammonium chloride (other alkyl or acyl groups may be used).	.....	.....	Indigo discharge in printing.
Leucotrop W	(Ditto)-sulphonated, Ca salt.	.....	.....	
Discharge salt W	Dimethylphenyl benzyl-ammonium (sulphate) disulphonic acid, Ca salt.	.....	.....	Discharge printing.
Rongalite CI	Leucotrop W and rongalite C.	.....	.....	Do.
Hydrosulphite CI	Leucotrop W and hydrosulphite N F.	.....	.....	Do.
Hydralite CI	Leucotrop W and hydralite A.	.....	.....	Do.
Anthraquinone	.....	[1] 29,850 $6,360	[1] 294,260 $547,787	Discharge catalyzer.
Tannoxyphenol R	Tannin and resorcin	.....	(2)	Nitroso blue by condensation.
Nitrose base M 50 per cent	Nitroso dimethyl aniline hydrochloride	.....	[1] 592,663 $364,091	
Ludigol	Nitro-anthraquinone sulphonic acid.	.....	.....	Organic oxidizing agent for preventing the reduction of vat dyes in the kier.

[1] Pound.
[2] See Resorcin.

DYES AND OTHER FINISHED PRODUCTS.

Introductory.—The finished products of the coal-tar chemical industry are many and diverse. They include (1) dyes, (2) color lakes, (3) photographic chemicals (developers), (4) medicinals, (5) flavors, (6) perfume materials, (7) synthetic phenolic resins.

(8) synthetic tanning materials, and (9) explosives. There are many other substances belonging to all of these classes (except the synthetic resins and synthetic tanning materials) that are not derived from coal tar and that do not need to be considered for the present purpose.

A few minor uses of coal-tar products hardly deserve separate classification for the present purpose. For example, sodium benzoate and sodium salicylate are used as food preservatives as well as for strictly medicinal purposes, but these uses are so closely allied that it does not seem proper to set up a separate class of food preservatives. Many dyes and lakes are used as inks or ink powders, either pure or mixed with gum or other vehicle. A separate classification would therefore result in the overlapping of the two classes of products. Some coal-tar chemicals, usually and properly classified as intermediates, are used for accelerating the vulcanization of rubber, the most important being aniline, thiocarbanilide, phenylenediamine, and nitrosodimethylaniline. As the substances used for this purpose belong to the class of intermediates and are so classified in the tariff law, it seems inadvisable to set up another class of finished products.

The technical and generic relationship of these different classes is exceedingly close. To a large extent they use the same intermediates. Phenol enters into the manufacture of some representatives of each of the nine classes of finished products. Aniline is used for making dyes, lakes, medicinals, photographic chemicals, and explosives. Numerous other examples showing this close relationship could be cited.

In previous reports[1] the commission has pointed out the close relation of dyes to explosives and poison gases and the ease with which a dye factory can be converted into an explosive or poison-gas plant in an emergency. Since the signing of the armistice certain plants in the United States which were erected for the manufacture of explosives have been used for the manufacture of intermediates and dyes.

A close relation also exists between the dye industry and the manufacture of flavors, perfume materials, photographic chemicals, and color lakes. A well-rounded and matured dye industry would inevitably be accompanied by these smaller offshoots, which in many cases would furnish an outlet for by-products obtained in making the intermediates needed for the dye industry. The synthetic phenolic resin industry and the synthetic tanning material industry are not so closely related to the dye industry as are the other cases cited. They are dependent chiefly upon phenol and formaldehyde, and therefore furnish an outlet in times of peace for the material, phenol, which is of such vital military importance.

[1] Census of Dyes and Coal-Tar Chemicals, 1918; pp. 36 and 38.

In general, the products derived from coal tar are treated alike in the tariff act of September 8, 1916. There are, however, exceptions to this generalization which the commission has pointed out in previous reports.[1]

Table 7 shows in as great detail as is permissible, without revealing the output of single firms, the production of finished coal-tar products during 1919. Table 8 compares the production in 1918 and 1919 of products for which output could be published. The outstanding developments in the various classes of dyes and other finished coal-tar products is discussed in detail beginning on page 43.

TABLE 7.—*Production of finished coal-tar products during 1919.*

[The number in the first column identifies the dye according to the 1914 edition of the Schultz tables. The second column gives the common name of the dye. The numbers in the third column refer to the numbered alphabetical list of manufacturers printed on p. 94. An x signifies that the corresponding product was made by a manufacturer who did not consent to the publication of his identification number in connection therewith. Blanks in the fourth and fifth columns indicate that there was actual production during 1919, but that the figures can not be published without revealing information in regard to the output of individual firms. The figures thus concealed are, however, included in the totals.]

Schultz No.	Common name.	Manufacturers' identification numbers.	Total production, 1919.		Average price per pound.
			Quantity.	Value.	
	Total finished coal-tar products		*Pounds.* 82,532,390	$84,585,544	$1.02
	NITROSO DYES.				
4	Naphthol green	5, 54, 66	34,646	38,831	1.12
	NITRO DYES.				
5	Picric acid	x	160,121	117,172	.73
7	Naphthol yellow	66, 77, x			
8	Pigment chlorine	x			
	STILBENE DYES.				
9	Direct yellow R	5, 53, 58, 112, 116, 123, x, x	440,924	767,674	1.74
11	Chloramine orange G	5, 58			
	PYRAZOLONE DYES.				
23	Tartrazine	24, 112			
	AZO DYES.				
	Monazo.				
28	Pigment fast yellow G	x			
31	Spirit yellow	x			
32	Butter yellow	69, 112, 121, x, x	31,156	47,964	1.54
33	Chrysoidine Y	27, 53, 64, 66, 69, 112, x	314,581	326,223	1.04
34	Chrysoidine R	27, 53, 54, 64, 69, 112	220,542	246,977	1.12
36	Sudan I	69, 112, 152, x	75,868	97,286	1.28
37	Croceine orange	54, 92, 112, 136, x	17,274	15,273	.88
38	Orange G	27, 112, 136			
39	Ponceau G	x			
40	Chromotrope 2 R	112, 116			
41	Fast acid fuchsine B	27, 40, 112, 116	26,699	45,222	1.69
42	Amido naphthol red G	64, 112			
48	Alizarine yellow GG	5, 53, 64, 92, 112, 120, 152, 167, x, x.	163,170	116,906	.72
56	Para nitranilin red	x			
57	Chromotrope 2 B	23, 116			
58	Alizarine yellow R	5, 23, 24, 40, 53, 64, 75, 78, 92, 116, 120, 136, 152, 167, x.	130,424	110,152	.84
59	Wool violet S	136			
61	Victoria violet	40, 112, 116	105,086	239,594	2.28
64	Lana fuchsine	116, 136, x	15,272	30,793	2.02

[1] Census of Dyes and Coal Tar Chemicals, 1918; pp. 36 and 38.

TABLE 7.—*Production of finished coal-tar products during 1919*—Continued.

Schultz No.	Common name.	Manufacturers' identification numbers.	Total production, 1919.		Average price per pound.
			Quantity.	Value.	
	AZO DYES—continued.				
	Monoazos—Continued.		*Pounds.*		
65	Azo coralline	64			
66	Amido naphthol red 6 B	64			
67	Chromotrope 6 B	5, 112, 116	77,481	$154,526	$1.99
68	Spirit yellow R	112, x			
70	Brilliant orange O	x			
73	Helio fast red	x			
76	Sudan II	69, 112, x			
79	Xylidine orange 2 R	136, x			
81	Brilliant cochineal	x			
82	Ponceau 2 R	5, 24, 27, 68, 112, 136, x, x	552,680	439,515	.80
83	Ponceau 3 R	75, 112, x	24,152	128,201	5.31
88	Acid anthracene brown R	112			
89	Metachrome brown B	53			
94	Azo Eosine	116			
102	Diamond flavine G	23, x			
105	Sudan brown	x			
106	Autol red	x			
107	Sulphamine brown A	136			
109	Palatine red A	136			
111	Fast red BT	136, x			
112	Bordeaux B	5, 24, 27, 68, 92, 112, 136, x.	161,862	146,810	.91
114	Chromotrope 10 B	116			
117	Erica 2 GN	58			
118	Geranine	58			
119	Diamine rose	112, 123			
120	Salmon red	x			
121	Erica B	58, 68			
132	Lake red P	136			
134	Metanil yellow	50, 53, 54, 64, 112, x	477,143	787,110	1.65
138	Methyl orange	57, 121			
139	Orange IV	x			
141	Azo yellow	112			
143	Tropaeoline	69			
144	Orange I	112, x			
145	Orange II	5, 24, 27, 53, 57, 64, 69, 112, 117, 120, 136, x, x, x.	1,133,925	717,199	.63
151	Orange R	69			
152	Permanent red 4 B	x			
153	Lake red C	x			
154	Palatine chrome brown	23, 112			
155	Acid alizarine garnet R	23			
156	Palatine chrome violet	23, 112			
159	Acid alizarine black R	23			
160	Fast brown N	64			
161	Fast red A	5, 27, 53, 69, 92, 112, 116, 120, 136, x.	267,582	280,974	1.05
163	Azo rubine	5, 27, 43, 64, 92, 112, 116, x.	187,264	267,129	1.43
164	Fast red VR	112			
166	Fast red E	5, x			
167	Crocein scarlet 3 BX	x			
168	Amaranth	24, 27, 92, 112, 116, 136, 158, x, x, x.	294,416	877,491	2.98
169	Cochineal red	5, 24, 27, 92, 112, 136, x	231,519	305,445	1.32
173	Lithol red R	112, 136, 150, x	269,169	103,926	.39
177	Mordant yellow	136			
180	Eriochrome blue black B	152			
181	Salicine black U	27, 53, 54, 64, 92, 112, 116, 136, 152.	739,372	923,888	1.25
183	Eriochrome black T	23			
184	Eriochrome black A	23, 64, 92, 112	686,710	933,677	1.36
188	Sulphon acid blue R	112			
189	Sulphon acid blue B	112			
190	Benzo brown 5 R	123			
193	Stanley red	123			
194	Thiazine red R	116			
195	Rosophenine SG	x			
196	Titan red	x			
197	Thiazine red G	64, 123, x	11,886	14,266	1.20
198	Mimosa C	123			
200	Lake red D	136, 150			
201	Pigment scarlet G	150			

TABLE 7.—*Production of finished coal-tar products during 1919*—Continued.

Schultz No.	Common name.	Manufacturers' identification numbers.	Total production, 1919.		Average price per pound.
			Quantity.	Value.	
	AZO DYES—continued.				
	Monoazos—Continued.		*Pounds.*		
202	Palatine chrome red B	112, 136, 150, x	28,081	$79,928	$2.85
	All other monoazo dyes	23, 24, 40, 53, 57, 64, 69, 75, 92, 112, 116, 121, 136, x, x, x, x.	939,936	1,199,733	1.27
	Total monoazo dyes		8,881,810	11,560,384	1.30
	Disazo dyes.				
208	Leather brown	136			
211	Resorcin brown	112			
213	Fast brown	112			
217	Algama black 10 B	5, 27, 40, 53, 64, 75, 92, 112, 116, 120, x.	1,877,860	2,757,443	1.47
223	Sudan III	x			
224	Cloth red G	x			
227	Brilliant croceine	5, 27, 112	157,509	379,491	2.41
228	Erythrine P	27			
232	Sudan IV	69, 112, x			
233	Cloth red B	92, x			
235	Croceine 3 B	x			
236	Wool red B	112			
241	Neutral gray G	116			
244	Coomassie wool black S	136			
246	Cloth scarlet G	69			
247	Scarlet E C	54, 112			
257	Sulphocyanine	112			
261	Buffalo black 10 B	112			
264	Fast sulphon black F	x			
265	Sulphocyanine black B	112			
266	Naphthylamine black	5			
272	Brilliant black B	116			
275	Diamond black	92, 112, 167	222,938	329,989	1.48
279	Benzo fast scarlet	58			
283	Bismark brown Y	27, 53, 58, 64, 69, 74, 112, 116, x.	412,574	117,276	1.28
284	Bismark brown 2 R	27, 53, 54, 64, 69, 112	631,308	659,332	1.04
289	Palatine chrome black S	40			
303	Paper yellow	112, 116, x, x, x	48,723	61,711	1.27
304	Chrysophenine G	58, 112, 116, 165, x	86,795	219,215	2.53
307	Congo red	43, 112, 116, 120, x, x	873,734	979,285	1.12
311	Orange TA	112, x			
312	Congo Corinth G	5, 43, 112, 116, x	137,704	266,770	1.93
320	Bordeaux	x			
322	Trisulphon violet B	112-x			
327	Diamine violet N	92, 112			
329	Diamine brown V	58			
333	Oxamine black BHN	5, 53, 92, 112, 116	485,046	1,321,362	2.72
337	Benzo blue 2 B	5, 13, 27, 40, 43, 53, 58, 75, 112, 116, 120, 154, 165, x, x.	1,390,335	1,396,291	1.00
340	Benzo orange R	43, 116, x, x, x	42,907	37,829	.88
341	Crumpsall direct fast red R	x, x			
342	Chrysamine G	40, 112, x, x, x, x	54,279	73,723	1.36
343	Diamine fast red F	92, 112, 116	56,864	154,780	2.72
344	Diamine brown	92, 112, 116	15,959	35,067	2.20
351	Cresotine yellow	43, 112			
352	Direct violet R	116			
355	Anthracene red	68, 116			
362	Oxydiamine orange	112			
363	Benzopurpurine 4 B	13, 53, 75, 92, 112, 116, 154, x	288,021	517,706	1.80
365	Benzopurpurine B	5, 112			
375	Congo Corinth B	x			
377	Azo blue	92			
378	Trisulphon blue R	116			
386	Benzo blue BX	112, 116, x, x	92,211	162,745	1.76
391	Benzo blue 3 B	5, 13, 27, 92, 112, 116, 154, x, x	182,946	309,066	1.69
392	Tolylene orange G	112			
405	Benzopurpurine 10 B	112, 116			
410	Benzazurine G	53, 112, 116	150,589	479,460	3.18
415	Diami blue G	116			
419	Chicago blue RW	116			
424	Chicago blue 6 B	116			
426	Benzamine pure blue	53, 75, 112, 116, 154	192,350	378,537	1.97
	All other disazo dyes	23, 53, 69, 112, 116, x, x, x	491,321	732,951	1.49
	Total disazo dyes		9,307,768	14,401,615	1.55

TABLE 7.—*Production of finished coal-tar products during 1919*—Continued.

Schultz No.	Common name.	Manufacturers' identification numbers.	Total production, 1919.		Average per price pound.
			Quantity.	Value.	
	AZO DYES—continued.				
	Trisazo dyes.		*Pounds.*		
436	Columbia black FF	112			
441	Diazo blue black RS	116			
450	Benzo black blue R	x			
462	Direct deep black EW	5,40,43,53,112,116,165,x,x	7,250,007	$7,521,343	$1.04
463	Cotton black E	112,116			
464	Erie direct green ET	43,112,x	69,709	134,408	1.93
469	Chloramine black N	116			
470	Chloramine green B	116			
471	Chloramine blue 3 G	116			
474	Oxamine green B	5,53,75,112,116,x	305,854	565,873	1.85
475	Oxamine green GX	13,43,53,x,x	136,638	291,758	2.14
476	Benzamine brown 3 GO	43,112,x			
477	Congo brown G	5,112			
	All other trisazo dyes	75,112,x,x,x	131,960	198,846	1.51
	Total trisazo dyes		8,829,578	10,217,788	1.16
	Tetrakisazo dyes.				
485	Benzo brown G	13,43,x	83,506	192,536	1.23
	Other tetrakisazo dyes	116			
	All other azo dyes	13,58,92,123,x	81,472	124,493	1.53
	Total of azo dyes		27,191,371	36,416,702	1.34
	DIPHENYLMETHANE DYES.				
493	Auramine	23,53,66	127,567	392,744	3.08
	TRIPHENYLMETHANE DYES.				
495	Malachite green	40,50,53,95,112,166,x,x,x	560,301	$1,827,474	3.26
499	Brilliant green	95,x			
502	Guinea green	31,112			
503	Brilliant milling green B	112			
505	Light green	158			
506	Erioglaucine	112			
511	Para-fuchsine	112			
512	Magenta	13,33,50,53,66,69,80,86,112,125,136,x,x,x.	155,830	712,066	4.57
513	New fuchsine	112,140			
515	Methyl violet	27,49,53,66,69,74,112,117,146,171,x.	574,436	1,403,179	2.44
516	Crystal violet	23			
521	Aniline blue	69,136,x			
528	Fast acid violet 10 B	116			
530	Acid violet	31,112			
535	Methyl alkali blue	136			
536	Alkali blue	50,69,80,112,136,146,x,x	77,796	494,133	6.35
537	Methyl blue for silk	50,80			
539	Soluble blue	50,69,112	16,315	90,613	5.55
	All other triphenylmethane dyes	23,112			
	Total triphenylmethane dyes		1,761,742	6,494,720	3.69
	DIPHENYL-NAPHTHYL-METHANE DYES.				
559	Victoria blue B	23			
560	Night blue	x			
566	Wool green S	5,23			
	XANTHONE DYES.				
573	Rhodamine B	53			
580	Fast acid violet B	95			
585	Uranine	53,69			
587	Eosine	53,66,69,117	121,303	764,179	6.30
592	Erythrosine B	69,x			
593	Phloxine P	53			
597	Rose Bengale B	69			
599	Galliene	150,169			
600	Coerulein B	169			
601	Coerulein S	150			
	Total xanthone dyes		190,138	1,235,526	6.50

TABLE 7.—*Production of finished coal-tar products during 1919*—Continued.

Schultz No.	Common name.	Manufacturers' identification numbers.	Total production, 1919. Quantity.	Total production, 1919. Value.	Average price per pound.
	ACRIDINE DYES.		Pounds.		
602	Acridine yellow	112			
606	Phosphine	69, 72, 112	14,648	[illegible]	[illegible]
	Other acridines dyes	72			
	THIOBENZENYL DYES.				
615	Thioflavine S	123			
616	Primuline	18, 112, 123, x, x, x, x	271,326	461,270	1.71
617	Columbia yellow	18, 54, 112, 116, 123, x	34,677	143,221	2.06
	Other thiobenzenyl dyes	123			
	INDOPHENOL DYES.				
619	Indophenol	77, 112, 151	126,611	201,737	1.59
	Other indophenol dyes	92			
	OXAZINE AND THIAZINE DYES.				
622	Delphine blue B	40, 112, 152	42,827	104,184	2.43
626	Gallocyanine	5, 24, 40, 64, 112, x	365,263	1,186,346	3.25
631	Chromocyanine V	112			
649	Cotton blue	92, x			
656	Alizarine green G	64			
659	Methylene blue	24, 27, 40, 53, 68, 98, 112, 127, 159, 166, x, x.	465,992	1,410,709	3.03
660	Methylene green	92, 112, x	2,435	11,694	4.80
667	Brilliant alizarine blue	64			
	Other oxazine and thiazine dyes	x			
	Total oxazine and thiazines.		904,755	2,754,677	3.04
	AZINE DYES.				
672	Azo carmine GX	53, 68			
679	Safranine	29, 66, 74, 112, 127	131,042	527,231	4.02
681	New fast gray	68, 116, x, x	28,458	48,544	1.71
683	Safranine M N	112			
697	Induline (spirit soluble)	18, 64, 112, x	436,201	231,283	.53
698	Nigrosine (spirit soluble)	24, 27, 64, 69, 112	346,167	245,508	.71
699	Induline (water soluble)	18, 53, 64, 69	130,704	87,494	.67
700	Nigrosine (water soluble)	18, 24, 64, 66, 69, 112, 152	1,660,149	987,457	.59
	SULPHUR COLORS.				
720	Sulphur black	13, 40, 53, 64, 73, 92, 112, 114, 151, 166, x, x, x.	14,504,770	4,141,124	.29
	Sulphur blue	13, 17, 40, 45, 53, 64, 74, 92, 112, 116, 151, x.	1,622,762	1,797,469	1.11
	Sulphur brown	5, 40, 53, 58, 64, 74, 92, 112, 114, 116, 144, 148, 151, x, x, x.	805,861	378,129	.47
713	Thiophor bronze	x			
	Sulphur green	40, 64, 112, 116, 144, 151, x, x	277,641	279,149	1.01
	Sulphur yellow and orange	40, 53, 112, 116	276,400	228,441	.83
	Sulphur maroon	40, 58			
	Sulphur tan	144, x, x	81,905	27,567	.34
	Sulphur colors (various shades)	112			
	Total sulphur colors		17,624,418	6,901,734	.39
	ANTHRAQUINONE DYES.				
765	Indanthrene green B	53			
766	Indanthrene violet R	53			
778	Alizarin	112			
779	Alizarin orange	112			
782	Alizarin brown	40, 150, 160	40,426	63,674	1.56
784	Alizarin SX	112			
803	Alizarin blue WX	112			
842	Indanthrene blue GCD	53			
849	Indanthrene yellow G	53			
858	Alizarin saphirol B	112			

TABLE 7.—*Production of finished coal-tar products during 1919*—Continued.

Schultz No.	Common name.	Manufacturers' identification numbers.	Total production, 1919.		Average per price pound.
			Quantity.	Value.	
	INDIGO AND ITS DERIVATIVES.		*Pounds.*		
874	Indigo, synthetic	52, 53, 112	8,863,824	$5,233,719	$0.59
877	Indigotine or indigo extract	5, 14, 53, 112, 116, 146, x	1,699,670	1,093,724	.64
881	Bromo-indigo	52			
	ANILINE BLACK GROUP.				
922	Pigment aniline black paste	40			
923	Ursol DB	136			
	Unclassified dyes of unknown composition.	33, x			
	Total dyes		63,402,194	67,598,855	1.07
	COLOR LAKES.				
	Alizarin lakes	x, x, x			
	Blue	10, 21, 34, 40, 48, 53, 56, 60, 70, 102, 133, 138, 150, x, x, x, x, x, x, x, x, x, x, x, x, x, x, x, x, x	543,201	391,210	.72
	Brown	133, x, x, x, x	74,625	9,812	.13
	Green	10, 21, 34, 48, 53, 56, 70, 96, 102, 138, x, x, x, x, x, x, x, x, x, x, x, x.	466,977	214,697	.46
	Maroon	10, 21, 34, 48, 53, 56, 70, 133, x, x, x, x, x, x, x, x, x, x, x, x.	697,699	260,769	.37
	Orange	10, 21, 34, 133, 150, x, x, x, x, x, x, x, x, x, x.	246,710	92,291	.37
	Para red	40, 102, 161, x, x, x	484,306	148,152	.31
	Purple lake B	150, x, x, x	6,581	4,519	.69
	Red	10, 21, 34, 48, 53, 56, 70, 96, 102, 138, 161, x, x, x, x, x, x, x, x, x, x, x, x, x, x.	2,101,527	986,765	.47
	Scarlet	10, 21, 34, 48, 53, 56, 60, 70, 96, 133, 138, 150, x, x, x, x, x, x, x, x, x, x, x, x, x, x, x, x.	865,536	361,904	.42
	Violet	10, 21, 34, 40, 48, 53, 56, 60, 70, 96, 133, 137, 138, x, x, x, x, x, x, x, x, x, x, x, x, x.	259,378	345,078	1.33
	Yellow	10, 34, 48, 53, 60, 70, 102, 138, x, x, x, x, x, x, x, x, x, x, x.	610,445	238,324	.39
	Eosine	10, 21, 34, 48, 53, 56, 60, 70, 96, 102, 133, 138, 150, x, x, x, x, x, x, x, x, x, x, x, x, x.	524,030	530,804	1.01
	Lithol red	10, 21, 40, 48, 53, 60, 70, 82, 96, 102, 133, x, x, x, x, x, x, x, x, x, x, x, x, x, x, x, x, x, x, x, x.	565,316	570,687	1.01
	All other color lakes	x			
	Total color lakes		7,569,921	4,179,964	.55
	PHOTOGRAPHIC CHEMICALS.				
	Hydroquinone	104, 112, 131, 169, x	272,329	552,087	2.03
	Methyl p-amidophenol sulphate (metol).	7, 57, 112, 131, 139, x, x	59,024	508,434	8.61
	All other photographic chemicals.	121, 139			
	Total photographic chemicals.		335,509	1,059,340	3.16
	MEDICINALS.				
	Acetanilide, U. S. P	24, 104, 109, 136, x, x, x	918,795	440,066	.48
	Acetphenetidine	109			
	Acetylsalicylic acid (aspirin)	44, 52, 79, 107, 109, x, x, x, x	1,777,105	4,034,400	2.27
	Ammonium salicylate	x			
	Amylsalicylate	x			

TABLE 7.—*Production of finished coal-tar products during 1919*—Continued.

Schultz No.	Common name.	Manufacturers' identification numbers.	Total production, 1919.		Average price per pound.
			Quantity.	Value.	
	MEDICINALS—continued.		*Pounds.*		
	Anesthesine (ethyl p-amino benzoate).	1, x			
	Arsphenamine	47, 103			
	Bacteriological stains	72			
	Benzyl benzoate	61, 155			
	Bismuth b-naphthol	104, x			
	Bismuth tribromphenol	104			
	Chloramine T	1, 24, 109	40,907	$37,881	$
	Cinchophen (phenylcinchoninic acid).	1, 24			
	Copper sulphocarbolate	101			
	Refined creosote	116			
	Creosote carbonate	24, 116			
	Dibrom oxy mercury fluorescin.	81			
	Dioxyquinoline sulphate	59			
	Dichloramine T	1, 24, 109			
	Disinfectant	30, 164, 170	2,103,101	91,670	
	Guaiacol carbonate	53			
	Guaiacol crystals, U. S. P	53, 116			
	Guaiacol liquid	53, 116			
	Halazone	1, 24, 109	459	848	1.
	Indigo disulphonic acid	24			
	Magnesium salicylate	x			
	Methylsalicylate	36, 104, x, x	879,833	332,123	
	b-Naphthol benzoate	24, 61, 104, 121	36,701	156,562	4.
	b-Naphthol salicylate	121			
	Neoarsphenamine	47, x			
	p-Nitro benzoic acid	1			
	Phenolphthalein	109, 168			
	Phenolsulphonates	1, 104, x	33,711	16,333	.4
	Phenolsulphonephthalein	81			
	Procaine	1, x, x	3,448	330,334	95.
	Salol	104, 109, x	124,034	112,359	.9
	Sodium salicylate	44, 61, 104, 109, x, x	391,518	169,508	.4
	Sodium sulphocarbolate	101			
	Strontium salicylate	x			
	Zinc sulphocarbolate	101			
	Total medicinals		6,777,988	7,883,071	1.
	FLAVORS.				
	Coumarin	109, x			
	Ethyl benzoate	61			
	Ethylsalicylate	61			
	Methyl salicylate (see medicinals).				
	Saccharin	24, 26, 109, 131, x, x	547,988	1,017,091	1.
	All other flavors	61			
	Total flavors		610,825	1,318,654	2.
	PERFUME MATERIALS.				
	Amyl salicylate	61, x			
	Benzyl acetate	65, 141, 155, x	17,049	39,137	2.
	Benzyl benzoate	141, 155			
	Benzyl butyrate	61			
	Benzyl formate	x			
	Benzyl propionate	61, x			
	Benzyl valerate	61			
	Brom styrol	61, 141, 155			
	Cinnamic alcohol	x			
	Diethyl phthalate	61			
	Diphenyl oxide	141, x			
	Ethylanthranilate	61			
	Isobutyl benzoate	x			
	Methyl acetophenone	61, 155, x			
	Methylanthranilate	61, 155, x	695	8,260	11.
	Methyl phenylacetate	61, 155, x			
	Methyl phthalol	x			
	b-Naphthol ethyl ether (nerolin).	x			
	b-Naphthol methyl ether (yara yara).	x			
	Phenylacetaldehyde	61, 155			
	Phenyl ethylacetate	61, x			

TABLE 7.—*Production of finished coal-tar products during 1919*—Continued.

Schultz No.	Common name.	Manufacturers' identification numbers.	Total production, 1919.		Average price per pound.
			Quantity.	Value.	
	PERFUME MATERIAL—contd.		*Pounds.*		
	Phenyl acetic acid	x			
	Phenyl ethyl alcohol	x			
	Salicylic aldehyde	x			
	Total perfumes		41,419	$164,302	$3.97
	SYNTHETIC PHENOLIC RESINS.				
	Derived from cresol	39, 126, x			
	Derived from phenol	39, 126, x			
	Derived from solvent naphtha	x			
	Derived from p-coumarone	15, 53			
	Total resins		3,094,534	2,311,358	.75
	SYNTHETIC TANNING MATERIAL.				
	Liberty extract	92			

The following table shows a comparison of the published figures for 1918 and 1919:

TABLE 8.—*Comparison of production of finished coal-tar products, 1918 and 1919.*

Schultz No.	Name of dye.	Production, 1918.			Production, 1919.		
		Quantity.	Value.	Price per pound.	Quantity.	Value.	Price per pound.
	Total finished coal-tar products	*Pounds.* 76,802,959	$83,815,746	$1.09	*Pounds.* 82,532,390	$84,585,544	$1.03
4	Naphthol green	22,465	54,013	2.40	34,646	38,831	1.121
9	Direct yellow R	307,702	804,378	2.61	440,924	767,674	1.741
	MONOAZO DYES.*						
32	Butter yellow	27,669	30,979	1.12	31,156	47,964	1.54
33	Chrysoidine Y	376,495	290,363	.77	314,581	326,223	1.037
34	Chrysoidine R	137,035	166,826	1.22	220,542	246,977	1.12
36	Sudan I	29,670	37,188	1.25	75,868	97,286	1.282
37	Croceine orange	30,824	27,388	.89	17,274	15,273	.884
48	Alizarin yellow GG	2,233,208	1,525,617	.68	163,170	116,906	.717
58	Alizarin yellow R	385,910	352,940	.91	130,424	110,152	.845
82	Ponceau 2 R	1,189,054	937,502	.79	552,680	439,515	.795
112	Bordeaux B	200,415	205,355	1.02	161,862	146,810	.907
145	Orange II	916,890	619,034	.68	1,133,925	717,199	.633
161	Fast red A	242,215	249,251	1.03	267,582	280,974	1.05
163	Azo rubine	79,779	120,308	1.51	187,264	267,129	1.427
168	Amaranth	73,539	64,440	.88	294,416	877,491	2.98
173	Lithol red R	353,104	838,873	2.38	269,169	103,926	.386
181	Salicine black U	469,159	758,386	1.62	739,372	923,888	1.25
	Total monoazo dyes	8,581,763	9,228,280	1.07	8,881,810	11,560,384	1.3016
	DISAZO DYES.						
217	Algama black 10B	1,158,309	1,463,043	1.26	1,877,860	2,757,443	1.468
227	Brilliant croceine	84,643	162,875	1.92	157,509	379,494	2.409
283	Bismark brown Y	378,208	305,417	.81	412,574	417,276	1.011
284	Bismark brown 2R	295,080	286,664	.97	631,308	659,332	1.044
303	Paper yellow	1,664	5,668	3.41	48,723	61,711	1.266
304	Chrysophenine G	41,663	238,012	5.71	86,795	219,215	2.525
307	Congo red	587,153	1,178,589	2.01	873,734	979,285	1.120

TABLE 8.—*Comparison of production of finished coal-tar products, etc.*—Contd.

Schultz No.	Name of dye.	Production, 1918. Quantity.	Value.	Price per pound.	Production, 1919. Quantity.	Value.	Price per pound.
	DISAZO DYES—continued.	*Pounds.*			*Pounds.*		
337	Benzo blue 2B	1,523,985	$2,084,036	$1.37	$1,380,335	$1,386,291	$1.004
340	Benzo orange R	50,422	78,722	1.56	42,807	37,820	.883
342	Chrysamine G	28,846	44,159	1.53	54,279	73,723	1.358
363	Benzo purpurine 4B	356,522	875,645	2.46	288,021	517,706	1.797
391	Benzo blue 3B	99,645	221,771	2.23	182,946	309,066	1.689
	Total disazo dyes	7,459,601	12,705,048	1.70	9,307,768	14,401,615	1.55
	TRISAZO DYES.						
474	Oxamine green B	295,147	649,125	2.20	305,654	565,873	1.850
475	Oxamine green GX	29,118	60,860	2.16	136,638	291,758	2.135
	Total trisazo dyes	7,518,099	8,105,563	1.08	8,829,578	10,217,788	1.157
	Total azo dyes	24,931,556	32,039,232	1.28	27,191,371	36,416,702	1.34
	DIPHENYLMETHANE DYES.						
493	Auramine	45,634	171,807	3.76	127,507	392,744	3.079
	TRIPHENYLMETHANE DYES.						
495	Malachite green	290,416	1,626,466	5.60	560,301	1,827,474	3.261
512	Magenta	71,675	553,359	7.72	155,830	712,066	4.592
515	Methyl violet	632,196	1,756,775	2.78	574,436	1,403,179	2.442
536	Alkali blue	43,184	359,897	8.33	77,796	494,133	6.352
	Total triphenylmethane dyes	1,262,704	5,791,588	4.59	1,761,742	6,494,720	3.69
	XANTHONE DYES.						
587	Eosine	161,153	1,258,549	7.81	121,303	764,179	6.30
	THIOBENZENYL DYES.						
616	Primuline	72,788	221,154	3.04	271,338	464,870	1.713
617	Columbia yellow	123,816	440,250	3.56	54,077	143,831	2.66
	OXAZINE AND THIAZINE DYES.						
626	Gallocyanine	435,460	2,231,827	5.12	365,243	1,105,346	3.026
659	Methylene blue	312,572	873,804	2.80	465,992	1,410,760	3.03
	AZINE DYES.						
679	Safranine	106,591	623,560	5.85	131,042	527,231	4.023
681	New fast gray	16,746	19,662	1.17	28,458	48,544	1.706
697	Induline (spirit soluble)	8,589	12,551	1.46	436,201	231,233	.530
698	Nigrosine (spirit soluble)	314,151	222,986	.71	346,167	245,508	.709
699	Induline (water soluble)	91,724	64,495	.70	130,704	87,494	.669
700	Nigrosine (water soluble)	1,191,343	755,846	.63	1,660,149	967,457	.583
	SULPHUR DYES.						
720	Sulphur black	12,385,130	4,427,507	.37	14,504,770	4,141,124	.286
	Sulphur blue	1,056,691	1,525,762	1.45	1,622,762	1,797,469	1.108
	Sulphur brown	5,309,044	2,558,995	.48	805,861	378,129	.47
	Sulphur green or olive	364,698	296,840	.81	277,641	279,149	.941
	Sulphur yellow and orange	521,421	567,060	1.09	276,400	228,441	.83
	Sulphur tan	337,549	219,280	.65	81,905	27,567	.337
	Total sulphur colors	23,698,826	10,812,686	.46	17,624,418	6,901,734	.392
	INDIGO AND ITS DERIVATIVES.						
874	Indigo, synthetic	3,083,888	2,724,134	.88	8,863,824	5,233,719	.591
877	Indigotine or indigo extract	1,434,703	883,668	.62	1,699,670	1,093,724	.644
	Total dyes	58,464,446	62,026,390	1.07	63,402,194	67,598,855	1.07
	COLOR LAKES.						
	Blue	733,244	416,131	.50	543,201	391,210	.72
	Green	1,042,803	278,168	.27	466,977	214,697	.46

TABLE 8.—*Comparison of production of finished coal-tar products, etc.*—Contd.

Schultz No.	Name of dye.	Production, 1918. Quantity.	Value.	Price per pound.	Production, 1919. Quantity.	Value.	Price per pound.
	COLOR LAKES—continued.	*Pounds.*			*Pounds.*		
	Maroon	632,826	$237,322	$0.38	697,699	$260,769	$0.37
	Orange	694,350	374,456	.54	246,710	92,291	.374
	Para red	165,039	141,857	.86	484,306	148,152	.306
	Red	1,828,942	844,450	.46	2,101,527	986,765	.47
	Scarlet	1,258,364	720,640	.57	865,536	361,904	.42
	Violet	245,017	233,196	.95	259,378	345,078	1.330
	Yellow	1,913,123	626,922	.33	610,445	238,324	.39
	Eosine	303,511	312,352	1.03	524,030	530,804	1.01
	Lithol red	632,663	801,765	1.27	565,316	570,687	1.01
	Total color lakes	9,590,537	5,020,023	.52	7,569,921	4,179,964	.55
	PHOTOGRAPHIC CHEMICALS.						
	Hydroquinone	305,774	659,488	2.16	272,329	552,087	2.03
	Methyl p-amidophenol sulphate (Metol)	10,975	164,427	14.98	59,024	508,434	8.61
	Total photographic chemicals	316,749	823,915	2.60	335,509	1,059,340	3.16
	MEDICINALS.						
	Acetanilide, U. S. P	939,062	615,158	.66	918,795	440,066	.479
	Acetylsalicylic acid (aspirin)	961,113	3,130,640	3.26	1,777,105	4,034,400	2.27
	b-Naphthol benzoate	13,975	96,144	6.88	36,701	156,562	4.266
	Phenolsulphonates	55,913	40,013	.72	33,711	16,333	.485
	Salol	271,945	406,072	1.49	124,034	112,359	.906
	Sodium salicylate	547,117	469,804	.86	301,518	169,508	.562
	Total medicinals	3,623,352	7,792,984	2.15	6,777,988	7,883,071	1.16
	FLAVORS.						
	Saccharin	425,600	4,489,617	10.55	547,968	1,017,091	1.856
	Total flavors	458,256	4,925,627	10.75	610,825	1,318,654	2.16
	PERFUME MATERIALS.						
	Benzyl acetate	30,193	101,284	3.35	17,049	39,137	2.296
	Total perfume materials	116,263	584,695	5.03	41,419	164,302	3.966

DYES.

In Table 9 the dyes have been arranged according to the method of application on the fiber into the following classes: (1) Direct dyes; (2) vat dyes, further subdivided into indigo and other vats; (3) acid dyes; (4) sulphur dyes; (5) mordant dyes; (6) basic dyes; (7) color lake and spirit soluble dyes; (8) unclassified dyes. The available information on dyes including imports during the 1914 fiscal year and domestic production from 1917 to 1919 inclusive has been arranged in this manner and the totals for each group are shown in Table 9.

Although the distinction between certain groups is not clear cut, particularly between acid and mordant dyes, still it is believed that this grouping more nearly reflects the progress in the industry than does that of Tables 7 and 8, which classify the dyes according to

chemical structure. This is especially true from the consumer's standpoint, as he is directly concerned with the application of the dye on the fiber. This same information is also shown graphically in figure 1, page 45.

TABLE 9.—*Comparison of imports, 1914, with the production of dyes by classes, 1917, 1918, and 1919.*

Class.	1914		1917		1918		1919	
	Imports.	Per cent of total.	United States production.	Per cent of total.	United States production.	Per cent of total.	United States production.	Per cent of total.
	Pounds.		*Pounds.*		*Pounds.*		*Pounds.*	
Direct	10,264,757	22.34	11,181,761	24.32	12,285,683	21.01	14,444,934	22.78
Vat (including indigo)	10,352,663	22.53	289,296	.63	3,281,337	5.61	9,252,982	14.59
(*a*) Indigo	8,407,359	.....	274,771	.....	3,083,888	.....	8,863,824	.....
(*b*) Other vats	1,945,304	.....	14,525	.....	197,449	.....	389,158	.....
Acid	9,286,501	20.21	9,372,121	20.38	9,799,071	16.76	12,195,968	19.23
Sulphur	7,053,879	15.35	15,588,222	33.91	23,698,826	40.53	17,624,418	27.78
Mordant	4,450,442	9.69	4,164,902	9.06	5,447,192	9.32	3,985,050	6.28
Basic	3,002,480	6.53	2,078,043	4.52	2,879,639	4.93	4,036,532	6.37
Dyes for color lakes and spirit soluble dyes	1,512,605	3.29	934,360	2.03	1,068,466	1.83	1,813,199	2.86
Unclassified	27,568	.06	2,368,541	5.15	4,232	.01	49,111	.08
Total	45,950,895	100.00	45,977,246	100.00	58,464,446	100.00	63,402,194	100.00

Direct dyes.—From a study of Table 9 and figure 1 it is seen that in 1917 the domestic production of direct dyes slightly exceeded the 1914 import. There has been a small but steady increase each succeeding year culminating in an output of over 14,000,000 pounds in 1919. This is an increase of about 40 per cent over the prewar imports and of 17.5 per cent over the 1918 output. This class of colors ranked second in quantity of output in 1919 and accounted for about 22 per cent of both the 1914 import and 1919 production. Of more importance than the increased output was the decrease in quantity of the dyes of lesser importance in this group, which was more than offset by an increased output of the better dyes and the appearance of new dyes of a faster type. Thus there was a greater variety of direct dyes from which the consumer could make his selection for dyeing cotton, half wool, and half silk goods.

Direct Deep Black EW with a total output in 1919 of 7,250,007 pounds valued at $7,521,343, an increase over 1918, accounted for over 50 per cent of the production of direct dyes. Benzo Blue 2B ranked second in this group with an output of 1,380,335 pounds valued at $1,386,291, a slight decrease from 1918.

Other important dyes in this class which showed an important gain in quantity produced in 1919 were as follows: Congo Red, increased by 50 per cent; Primuline, by 300 per cent; Benzo Blue 3B, by 100 per cent; and Chrysamine G, by 100 per cent; and Oxamin-

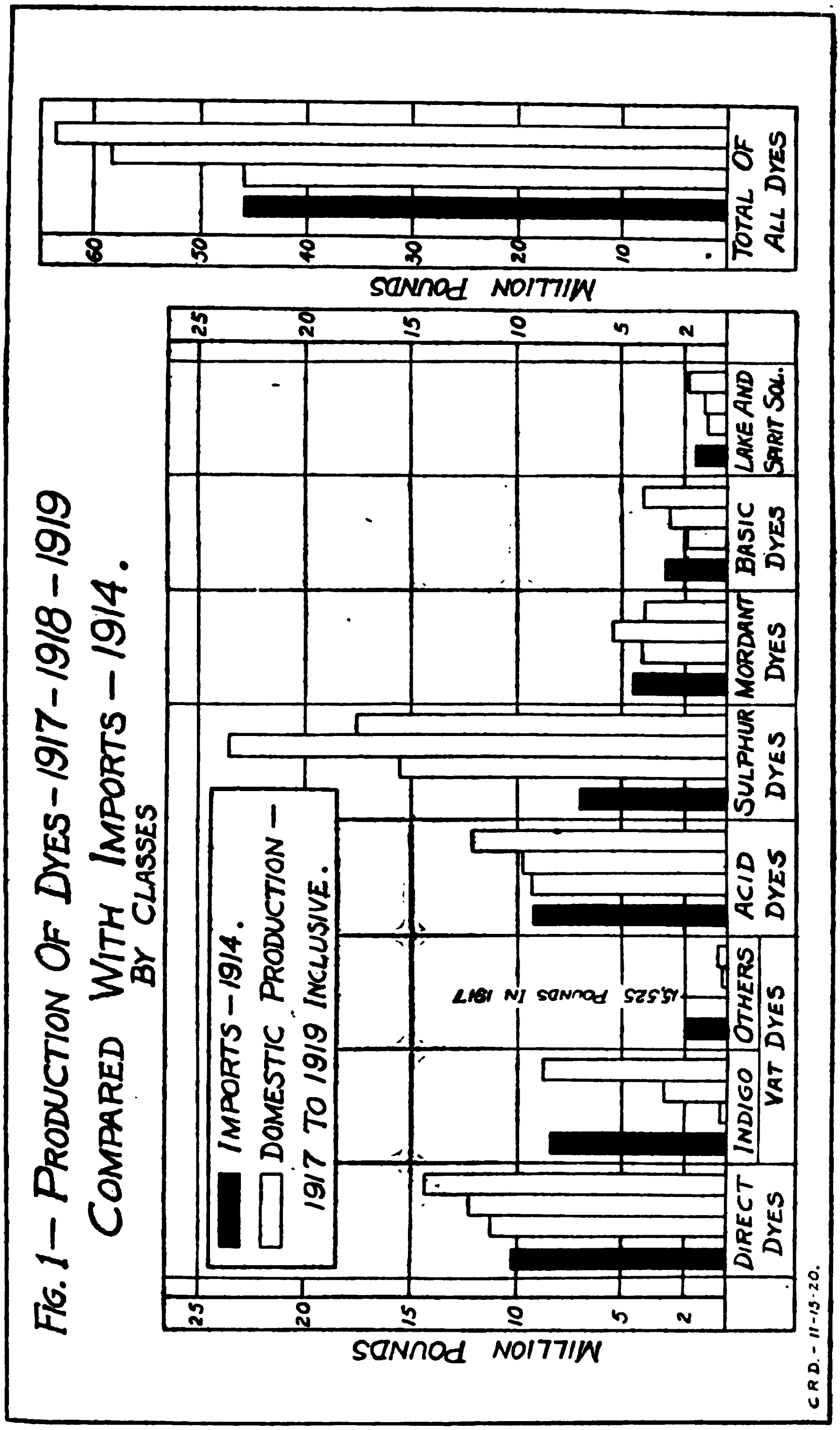

FIG. 1 — PRODUCTION OF DYES — 1917 — 1918 — 1919 COMPARED WITH IMPORTS — 1914. BY CLASSES

Black B. H. N., Oxamine Green B, Benzazurine, and Oxamine Green G; also showed large increases over the output of 1918, which could not be published.

The following direct colors made their first appearance in 1919: Those produced in considerable quantity include Chloramine Black N, Diamine Fast Red F, Chloramine Blue 3G, Cotton Black E, Chicago Blue 6B, Dianil Blue B, Chloramine Green B, Diamine Violet N, Oxydiamine Orange R, Chicago Blue R and W, and Erica B; others produced in smaller quantities than those already mentioned include: Erica 2GN, Diazo Blue Black RS, Congo Corinth, Benzo Black Blue R, Diamine Brown, Benzo Fast Scarlet, Titan Red 3B, Azo Blue, Brilliant Hessian Purple, Salmon Red, Benzo Brown 5R, Rosephenine 10B, Thio-flavine S, Benzo Blue R, and Geranine. Several other direct dyes were produced in large quantities. These could not be identified according to Schultz but are included in the total for this class.

Indigo and other vat dyes.—It is in this class of dyes that the domestic industry has been particularly backward, and in 1919 the quantity of vat dyes, with the exception of indigo which is the most important, was still inadequate for domestic needs.

The production of indigo (20 per cent paste) during 1919 of 8,863,824 pounds, a slight increase over 1914 imports, may be regarded as the most important development of the American dye industry in 1919. The output exceeded the domestic demand and large quantities of indigo were exported. Of all the dyes produced in this country indigo ranks second only in quantity to sulphur black, but exceeds it by over $1,000,000 in value. Brom-indigos, which are of great value for cotton dyeing and printing, were manufactured in considerable quantity in 1919.

The manufacture of vat dyes, not including indigo, is less developed and the output more inadequate for our domestic needs than any other class. During 1919 four vat dyes (yellow, blue, green, and violet) were placed on the market during 1919 by one firm, but the output was only a small fraction of the domestic demand. A second firm announced the production of three vat dyes in 1920. Other concerns have also worked on vat colors, several of which, including two yellows and a red, have already been offered for sale. This indicates that fundamental developments in this field are under way and an increased output of vat colors during 1920 may be expected. The manufacture of these dyes has required the highest technical skill, long research, and a large investment of capital. On account of the present small domestic production they are probably the most needed of all, although the normal quantity consumed

annually is smaller than that of other classes of dyes. They are used for dyeing and printing fast colors on cotton and. to a lesser extent, on silk.

Vat dyes, other than indigo, were imported during 1914 to the extent of nearly 2,000,000 pounds or about 4 per cent of the total for that year. The production of these dyes in 1919 was about 390,000 pounds or only one-fifth of the prewar requirements. The future development of a balanced industry will necessitate a greatly increased output of these dyes. This will be possible only when an increased output of anthracene or synthetic anthraquinone has been attained. The development of a variety of vat colors should also include the manufacture of thio-indigoids.

Acid dyes.—The prewar imports of acid dyes were equaled by the domestic output in 1917. Since then the production has increased each year, amounting in 1919 to 12,000,000 pounds, which is an increase of nearly one-fourth the 1918 output and about 30 per cent in excess of the 1914 import. Acid dyes rank third in the quantity produced in 1919 and accounted for about 19 per cent of the total output of dyes. This group of dyes ranks next to sulphur dyes, in being the most fully developed in the domestic industry. The consumer should have no trouble in securing a good variety and quantity of acid dyes.

In quantity produced during 1919, the most important dyes in this class were Algama Black 10 B, with a production of 1,877,860 pounds, an increase of 62 per cent over 1918; Indigotine, or indigo extract, 1,699,670 pounds, an increase of 18.5 per cent; and Nigrosine (water soluble), 1,660,149 pounds, an increase of 39 per cent over 1918. Other dyes in this class which showed an important gain in 1919 as against 1918 were: Metanil Yellow, which increased by 100 per cent; Cochineal Red, 400 per cent; and Alizarin Saphirol B, Fast Red A, Azo Rubine, Brilliant Crocein, and Victoria Violet also showed marked increase over 1918 figures which would not be published.

Eosine, Bordeaux B, and Ponceau 2 R showed a marked decline in output during 1919.

Among other important dyes of this class are the following: Naphthol Yellow, Alkali Blue, Tartrazine. Amaranth, Guinea Green, Scarlet EC, Fast Red VR, Resorcin Brown, Azo Yellow and Violet, Sulphonic Acid Blue R, Buffalo Black 10 B, Wool Red B, Chromotrope 6 B, Fuchsine B.

Among the acid dyes produced for the first time in 1919 there may be mentioned Uranine, Sulphonic Acid Blue B, Chromotrope 10 B, Brilliant Cochineal, Wool Green S, Erio-glaucine, Erythrine B, Cloth Red G, Crocein 3 B, Neptune Green, Light Green, Fast Sulphon Black F, Ponceau G.

Sulphur dyes.—In quantity output the sulphur dyes have ranked first each year beginning with 1917, although they ranked only fourth in prewar imports. The domestic output in 1917 was over 15,000,000 pounds, or more than double the imports of 1914. There was an increase to a maximum in 1918 of more than 23,000,000 pounds. During 1919 the output decreased by one-fourth—to 17,624,418 pounds, which is still two and one-half times the prewar import. This reduction is more than accounted for in a decrease of over 8,000,000 pounds in sulphur olives and khakis required in cotton uniform cloth.

Of the total production of dyes in 1919, 28 per cent was sulphur colors; in 1918, 40 per cent, and of the 1914 imports 15 per cent. The production of Sulphur Black is larger than that of any other individual color. In 1919 it was 14,504,770 pounds, an increase of 17 per cent over 1918. This output was 260 per cent greater than the 1914 import of sulphur blacks. The production of Sulphur Blue increased over 50 per cent, to 1,622,762 pounds. Several new sulphur colors—maroon, bronze, orange, and blues—were added to the list in 1919. The sulphur dyes produced in 1919 were of greater purity and higher concentration than those of the previous year. The production of this class is the most highly developed of all classes of colors, and is in excess of the domestic needs so that large quantities have been exported. Sulphur Corinth was practically the only sulphur dye for which no production was reported in 1919. In the absence of vat dyes sulphur dyes have been of special value to the cotton trade.

Mordant dyes.—As is shown in Table 9 this class of dyes in 1917 had reached an output only slightly less than the 1914 import and in 1918 increased to about 5,500,000 pounds, or about 22 per cent in excess of the prewar import. During 1919 the production declined nearly 27 per cent to slightly less than 4,000,000 pounds. This decrease is accounted for by a reduced output of those dyes used in military uniforms—chiefly by Alizarin Yellow GG and Alizarin Yellow R (not true alizarin derivatives) used for khaki shades on woolen cloth and, to a lesser extent, by Gallocyanine used for blue Navy uniforms. Of these dyes the largest decrease in production was that of Alizarin Yellow GG, from over 2,000,000 pounds in 1918 to 160,000 pounds in 1919. If the dyes of this group used for military uniforms are eliminated, then the remaining mordant dyes show a substantial increase.

Marked progress has been made during 1919 in solving the diverse technical problems involved in the manufacture of mordant dyes, particularly those made from anthracene. Probably the most important development in mordant dyes is the large increase shown in the output of Alizarin. The availability of this dye, which is one

of the fastest known, filled an important requirement of dye consumers. Mordant dyes which appeared for the first time in 1919 include Alizarin SX, Galleine, Brilliant Alizarin Blue, Alizarin Green B, Alizarin Orange, Alizarin Garnet, and Coerulein, all of which are important in arriving at a complete dye industry. The successful production of several of these dyes represents intensive research work over an extended period and the investment of a large amount of capital for their commercial output.

Considerable increase was made in those dyes the manufacture of which had been previously established. The most important of these include Salicine Black U, which increased 57 per cent; and Erio Chrome Black A, and Diamond Black, which showed a large increase over 1918.

As previously pointed out the production of mordant dyes of the faster types derived from alizarin is entirely dependent upon an adequate supply of anthracene or synthetic anthraquinone.

The production of mordant dyes for 1919, grouped by color, was as follows:

	Pounds.
Blacks	1,991,064
Yellows	570,663
Blues	473,367
Browns	462,342
Reds	249,093
Greens	214,336
Violets	24,185

Color lake and spirit soluble dyes.—This class of dyes, as can be seen by referring to Table 9, in quantity produced are the least important, amounting in 1919 to less than 3 per cent of the total. But their importance can not be estimated by quantitative production, as they are used largely in the manufacture of color lakes, a very important class of pigments for paint, lithographic ink, and other industries.

The output of these dyes has doubled from 1917 to 1919, or from 934,360 pounds to 1,813,199. The 1919 output is 20 per cent in excess of the 1914 imports. Induline spirit soluble and nigrosine spirit soluble, with an output of 436,201 and 346,167 pounds, respectively, account for 43 per cent of the total production of these dyes. Important spirit soluble dyes also include Sudan I, Butter Yellow, Sudan Brown, Oil Red, Sudan II, Sudan IV, Spirit Yellow R and G.

There were three important dyes used for color lakes produced for the first time in 1919, namely—Lake Red C, Permanent Red 4 B, and Pigment Chlorine.

Dyes used in color lake manufacture include Lithol Red R, with an output in 1919 of 269,169 pounds valued at $103,926. Other impor-

tant dyes of this class include: Para Red, Helio Fast Red, Lake Red D, and Pigment Scarlet G.

Decreased consumption of natural dyes.—In 1916 the scarcity of coal-tar dyes led to an abnormal consumption of natural dyes. Since then the steady increase in the domestic output of coal-tar dyes has caused a marked decrease in the use of natural dyes. This forced use of natural dyes demonstrated their merits for certain purposes and has extended their field of application. Competition between natural and synthetic dyes results largely, but not entirely, in a victory for coal-tar dyes.

Imports of the more important natural dyes have shown a general decrease from 1916 to 1919. The total imports of crude logwood for consumption for the calendar year 1919 were 29,022 tons, as compared with 33,168 tons in 1918, and 40,921 tons in 1914. Logwood, the most important natural dye, is used chiefly for the production of blacks on silk, leather, and wool. It has advantages for black dyeing on silk and leather not possessed by artificial dyes. It also has extensive use for the production of black on wool. Natural indigo imports for consumption also declined from 1,637,914 pounds in 1918 to only 234,991 pounds in 1919, and in all probability will soon be negligible as was the case prior to the war.

Quercitron, the most important natural dye of domestic origin, is prepared from the bark of the black oak (*Quercus tinctoria*). It has extensive use in the dyeing of yellows, olive, and khaki shades.

OTHER FINISHED COAL-TAR PRODUCTS.

Color lakes.—The coal-tar products included in this group are a class of pigments used for paints, lithographic inks, and many other purposes. They are made by "fixing" a coal-tar dye on an inert base material, such as aluminum hydroxide, or barium sulphate (blanc fixe).

The total output of coal-tar color lakes in 1919 was 7,569,921 pounds, or a decrease of 25 per cent from 1918. Red lakes were first with an output of 3,151,149 pounds, or 42 per cent of total lakes. Of this quantity about 17.9 per cent was Lithol Red and 15.3 per cent Para Reds. The other important lakes in order of production in 1919 were scarlet, maroon, yellow, blue, eosine, green, violet, and orange.

Photographic chemicals.—The total output of coal-tar products used as developers in photography increased from 316,749 pounds in 1918 to 335,509 pounds in 1919. Hydroquinone, the most important product in this group, decreased 11 per cent in output to 272,329 pounds. Methyl p-amidophenol sulphate (metol), another impor-

ant photographic developer, showed more than a 400 per cent increase in production in 1919, as against that of 1918.

Medicinals.—The production of coal-tar medicinals in 1919, exclusive of deducting 2,103,101 pounds of disinfectants—a product not reported in 1918—showed an increase of 1,051,535 pounds, or 29 per cent more than the 1918 production. The total output, including the disinfectants, was 6,777,988 pounds, valued at $7,883,071.

Acetylsalicylic acid (aspirin) in 1919 accounted for over one-half of the total value of medicinals, the quantity produced being 1,777,105 pounds, or nearly double the 1918 output.

A large increase was reported in the production of acetphenetidine, chloramine T, phenolphthalein, neoarsphenamine, b-naphthol benzoate, guaiacol crystals U. S. P., and guaiacol liquid; while the following products showed a decrease in output: Arsphenamine, bismuth b-naphthol, bismuth tribromphenol, dichloramine T, phenolsulphophthalein and phenolsulphonates.

The following are among the medicinals which were reported in 1919 for the first time: Anesthesine (ethyl p-amino benzoate), cinchophen (phenylcinchoninic acid), dibromoxy-mercury-fluorescin, copper sulphocarbolate, sodium sulphocarbolate, zinc sulphocarbolate, creosote carbonate, guaiacol carbonate, b-naphthol salicylate, amyl salicylate, and ammonium salicylate. The progress made during 1919 in the production of a greater variety of coal-tar medicinals is an important addition to the American coal-tar industry.

Flavors and perfume materials.—Further progress was made during 1919 in the manfacture of flavors and perfume materials derived from coal tar. There is no sharp difference between these products, many of them being suitable for both flavors and perfumes. One of them, here considered as a flavor, is the substance saccharin, which in recent years because of the scarcity and high price of sugar, has had extensive use as a sugar substitute, and also as a sweetener in chewing tobacco. The output of saccharin was 547,988 pounds, valued at $1,017,091, or an increase of nearly 29 per cent over 1918. This increase was made possible through the release from military control of toluene, the raw material. The average price of saccharin decreased to $1.86 per pound as compared with $10.55 in 1918.

Coumarin, used both as a flavor and as a perfume in scented soaps, has more than doubled in output from 1917 to 1919. Synthetic coumarin has practically replaced the natural product derived from tonka beans.

Benzyl benzoate and benzyl acetate, ordinarily considered as perfume materials, were used in large quantities as solvents in the manufacture of varnish for aeroplane wings. Recently benzyl benzoate has been used with considerable success as a nonnarcotic antispas-

modic. The output of both products decreased in 1919. The output of benzyl benzoate in 1919 was less than one-twelfth the 1918 production, while benzyl acetate decreased nearly 50 per cent. Perfume materials whose output increased in quantity during 1919 include Bromstyrol, cinnamic alcohol, methyl acetophenone, methyl anthranilate, and methyl phenylacetate. Several perfume chemicals were reported in 1919 for the first time.

Synthetic resins.—Although the total 1919 output of synthetic resins was about the same as in 1918, the production of individual resins differed widely. Those resins, derived from phenol by condensation with formaldehyde and hexamethylenetetramine increased in quantity as compared with the 1918 figures. As a direct effect of this increase there was a decrease in output of resins obtained from cresol, a subsittute for phenol during the war. Resins made by condensation of solvent naphtha and paracoumarone showed an increased output in 1919. The synthetic phenolic resin industry, the products of which have many different uses, was created by inventions of American chemists. The development in the last few years has been achieved by laborious and painstaking research conducted with an intimate knowledge of the requirements in other industries in which these products are now used.

Synthetic tanning materials.—Synthetic tanning materials are of comparatively recent origin, having come into commercial use in Germany and England since 1912. They are made by the condensation of certain coal-tar derivatives and formaldehyde in the presence of an acid. They have proved their value for tanning, but they are sometimes sold in combination with a small amount of natural tanning extract. Their use results in (1) great economy of time required for tanning; (2) a satisfactory leather of light color, and (3) a reduction in the quantity of natural tanning extracts required. As the supply of domestic natural tanning materials is decreasing, the domestic tanning industry is becoming more and more dependent upon natural tanning materials of foreign origin. These synthetic products, therefore, promise to be of great importance in the future of the domestic industry. A single firm in this country reported the manufacture of these materials in 1919.

EMPLOYEES AND RATES OF PAY.

Employees and rates of pay.—Each of the 214 firms reporting the manufacture of coal-tar chemicals was asked to report the number of its employees receiving specified rates of pay on December 15, 1919, or the nearest representative date for which records were available. Twenty-four firms found it impracticable to give

the information. In most of these cases the primary products were not derived from coal tar and the departments were not separately organized in such a way that the number of men engaged in the manufacture of any one class of products could be definitely stated. Certain other firms had gone out of business during 1919.

One hundred and ninety-one firms reported a total of 24,736 employees engaged in the manufacture of coal-tar products, of which 2,605, or 10.5 per cent, were chemists or engineers. This is probably a larger proportion of technically trained men than will be found in any other important manufacturing industry in the United States. Employed in the main under the immediate or general direction of these technically trained men were 22,131 skilled artisans and unskilled laborers. This is an increase over 1918 of 369 in number of the first group, but a decrease of 2,861 in the number of employees without technical training.

Table 10 shows the number and percentage of employees engaged in manufacturing operations receiving specified rates of pay in each of the groups of technically trained and untrained men; and the percentage of the total of each group of employees receiving each specified rate of pay or more. The proportion of technically trained men receiving the higher rates of compensation is much greater than the proportion of untrained men. For example, 57.4 per cent of the technically trained men receive $40 or more per week, whereas only 12.7 per cent of the employees without technical training received $40 or more per week. Thirty-two per cent of the technically trained men received $50 or more per week, whereas only 2.6 per cent of the men without technical training received that sum.

TABLE 10.—*Employees and rates of pay.*

Wages per week.	Number of employees at each specified wage engaged in manufacturing operations.			Percentage receiving each specified wage.		Percentage receiving each specified wage or more.	
	Chemists and technically trained men.	Men without technical training.	All employees.	Of all chemists and technically trained men.	Of all men without technical training.	Of all chemists and technically trained men.	Of all men without technical training.
Under $10	1	120	121	0.04	0.54	100.00	100.00
$10, but under $15	6	440	446	.23	1.99	99.96	99.46
$15, but under $20	95	1,177	1,272	3.65	5.32	99.73	97.47
$20, but under $25	168	5,221	5,389	6.45	23.59	96.08	92.15
$25, but under $30	251	5,407	5,658	9.63	24.43	89.63	68.56
$30, but under $35	312	4,042	4,354	11.97	18.27	80.00	44.13
$35, but under $40	277	2,922	3,199	10.63	13.20	68.03	25.86
$40, but under $45	440	1,457	1,897	16.89	6.58	57.40	12.66
$45, but under $50	220	761	981	8.45	3.44	40.51	6.08
$50, but under $75	505	554	1,059	19.39	2.50	32.06	2.64
$75 and over	330	30	360	12.67	.14	12.67	.14
Total	2,605	22,131	24,736	100.00	100.00	.....	.....

A comparison with the corresponding figures for 1918 shows that wages during 1919 were substantially higher than in 1918. Especially was this true of employees without technical training, and technically trained employees who received less than $50 per week. For example, during 1918, 15.4 per cent of all employees without technical training received less than $20 per week whereas in 1919 only 7.8 per cent of such employees received less than $20 per week. Moreover in 1918, 5.9 per cent of all chemists or technically trained men received less than $20 per week whereas in 1919 only 3.9 per cent were receiving less than this weekly rate. During the same time the group of men without technical training receiving rates of pay greater than $20 per week increased by 7.6 per cent whereas chemists and technically trained men increased by only 2 per cent. At the high rates, however, this increased percentage is quite reversed. For example, there was an increase of 6.3 per cent in the group of technically trained men receiving $40 per week or more as compared with an increase of 0.5 per cent of employees without technical training.

In Table No. 11 a comparison is made of the percentages of technically trained men and men without technical training for 1918 and 1919. There was little change in 1919 as compared with 1918 in the percentages of both classes of men receiving the higher rates of pay ($50 and more per week).

Table 11 shows very clearly the great dependence of the industry on its technically trained employees.

TABLE 11.—*Comparison of employees, rates of pay, 1918 and 1919.*

Wages per week.	Percentage receiving each specified wage or more.					
	Of all chemists and technically trained men.			Of all men without technical training.		
	1918	1919	Increased percentage.	1918	1919	Increased percentage.
$10, but under $15	99.7	99.9	0.2	98.2	99.5	1.3
$15, but under $20	98.1	99.7	1.3	94.6	97.5	2.9
$20, but under $25	94.1	96.1	2.0	84.6	92.2	7.6
$25, but under $30	86.1	89.6	3.5	63.6	68.6	5.0
$30, but under $35	76.9	80.0	3.1	43.0	44.1	1.1
$35, but under $40	62.9	68.0	5.1	22.3	25.9	3.6
$40, but under $45	51.2	57.4	6.2	12.2	12.7	1.5
$45, but under $50	40.4	40.5	.1	6.5	6.1	.4
$50, but under $75	32.6	32.1	[1].5	2.6	2.6	.....
$75 and over	16.9	12.7	[1]4.2	.1	.1	.....

[1]Decrease.

RESEARCH WORK.

Of the total of 214 firms, 65 had separately organized research laboratories for the solution of technical problems in the manufacture

of their products and for the discovery of new products. During 1919 the net operating expenses of these research laboratories, together with the cost of research work done in the laboratories not separately organized for research, was $4,274,247. This includes salaries, apparatus, and materials, after deducting the value of salable products made in research laboratories. This figure is probably an understatement of the real cost of experimental work, since it does not include in all cases the cost of experimental work done as a part of manufacturing operations and not shown on the books of the companies as a charge against research.

NOTES ON DYE INDUSTRIES IN OTHER COUNTRIES.

Germany.—About 90 per cent of the productive capacity of German dye factories is located within the territory occupied by the allied and American troops. Inspection by the military authorities has disclosed the fact that during the war plants which formerly had manufactured dyes were engaged in a large scale production of explosives, and of poisonous gases. An inventory of the stocks of dyes on hand as of August 15, 1919, showed that the total was approximately 20,000 tons, which is probably about one-tenth of their annual prewar production.

Production of dyes in Germany during the first year after the signing of the armistice was practically negligible compared with the prewar output. Beginning with February, 1920, detailed statements of one-quarter of the monthly production (this portion is required to be reserved for optional purchases of the allied and associated Governments by the peace treaty, Annex VI, Part II) of every dye in each factory were made to the Reparations Commission. Copies of these monthly statements through October, 1920, have been received by the Department of State, which has given permission for their publication by the Tariff Commission. A summary of these reserved stocks in German dye plants is shown in Table 12.

During February, 1920, the quantity of dyes reserved by German plants totaled 876,449 pounds, indicating a total output of over 3,500,000 pounds for that month. A progressive increase is shown in each succeeding month to a maximum of 3,026,247 pounds in August, which indicates a total output of over 12,000,000 pounds monthly. Since August there has been a slight decline in reserved stocks to 2,779,132 pounds in October. The rate of production from July to October inclusive is only about one-third of Germany's prewar output.

TABLE 12.—*One-quarter of production in German dye plants [1] reserved for purchase of allied and associated governments. February to October, 1920.*

[Pounds.]

Group.	Classification of colors.	February.	March.	April.	May.	June.	July.	August.	September.	October.	Total for 8 months.
I	Alizarin red	28,629	100,347	79,070	121,401	241,194	206,251	210,328	198,632	215,028	1,403,880
II	Indigo paste	33,203	124,258	306,371	338,318	291,294	543,717	777,774	642,729	426,599	3,484,293
III	Vat colors, except Indanthrene Blue GCD	15,346	9,361	19,577	62,183	41,786	72,595	54,828	62,608	84,366	422,650
IV	Indanthrene Blue	3,135	.....	3,307	9,489	11,329	14,420	9,370	16,043	1,131	68,224
V	Alizarin colors other than red	17,240	22,862	40,622	54,643	92,022	63,411	69,612	88,658	58,440	507,510
VI	Direct colors for cotton	262,123	346,301	400,221	451,138	541,534	694,709	573,004	593,694	666,239	4,528,963
VII	Direct colors	63,402	51,495	54,586	44,687	88,131	126,983	113,973	95,139	117,562	756,258
VIII	Acid colors for wool	149,827	202,819	265,094	360,192	419,812	512,594	469,589	492,647	487,131	3,359,735
IX	Chrome colors for wool	61,313	91,257	95,605	182,287	182,647	195,246	200,504	208,760	216,057	1,383,676
X	Basic colors	19,912	44,374	72,289	106,555	124,035	126,723	144,595	163,661	151,145	953,289
XI	Sulphur colors	163,822	149,452	235,423	190,515	305,979	323,170	291,832	285,804	282,744	2,208,741
XII	Lake colors	56,958	164,229	156,163	150,085	170,742	136,196	110,838	73,565	92,690	1,111,466
XIII	Intermediate products	1,539	12,599	85,527	80,672	.....	.....	.....	.....	.....	189,337
	Total	876,449	1,319,354	1,813,855	2,114,165	2,510,535	3,016,045	3,026,247	2,922,240	2,779,132	20,378,022

[1] Peace Treaty, Annex VI, Part II

England.—At least six English firms were manufacturing dyes in 1914, and in addition two other factories at Ellsmere Port and Bromborough Port were operated by the Germans in order to comply with the patent act of 1907.

It has been estimated that these firms produced about 10 per cent of the dyes used in the United Kingdom in the year immediately preceding the outbreak of the war, with a total output not exceeding 2,000 tons annually.[1] The production included a fairly wide range of acids, direct, basic, and sulphur colors, and in addition a limited variety of alizarin derivatives. With the exception of indigo, vat dyes were not produced in England. Development since the war has been chiefly in the faster dyes including vats and alizarin derivatives, and has resulted in the production of a considerable variety in this field. The output, however, has not been sufficient to meet the domestic demand. Recent estimates indicate that the present production of fast dyes is about 25,000 tons annually.[1] The range of dyes produced, however, is limited. In January, 1920, the advisory committee of the British Color Users Association visited Germany, and arranged for the purchase of 140 tons of dyes to relieve the shortage of certain types in England.

Switzerland.—Although hampered by a lack of intermediates and other raw materials, the Swiss dye industry developed during the war to a remarkable degree, owing to the absence of German competition in the dye markets of the world.

Since 1915, the Swiss dye manufacturers have been under contract to supply English dye consumers with a large proportion of the dyes made from English intermediates and other English raw materials. England has therefore received more Swiss dyes than any other country. In 1918, the value of the exports of Swiss colors to England was over three times the value of those exported to the United States. Switzerland has also imported intermediates and other raw materials from the United States, France, and Italy.

The leading dye manufacturers of Switzerland have recently been consolidated into a single company. This company controls a branch in England and has purchased control of the dye factory of Ault & Wiborg, at Norwood, Ohio.

France.—The development of a dye industry in France has been slower than in the United States, England, or Switzerland. Several plants maintained by German firms before the war have been taken over and operated by French interests. They were located at Neuilly-sur-Saone (Rhone), Creil (Oise), Flers (Nord), Lyon, St. Fons (Rhone), and Tourcoing (Nord). These factories were probably established mainly for the purpose of evading the high French duty

[1] London Chemical Trade Journal, Mar. 6, 1920.

on manufactured dyes by importing the intermediates from Germany at a lower duty. By the establishment of these factories in France the Germans were able also to avail themselves of the free entry accorded goods of French manufacture by French colonies.

Japan.—Before the war, Japan annually imported, mainly from Germany,[1] dyes to the value of about $4,000,000. In 1915 a law was passed providing for subsidies to companies engaging in dye manufacture. The subsidies were to be in amounts sufficient to enable the companies to pay 8 per cent dividends upon their invested capital, and were to continue for 10 years. It is reported that at least three companies are thus subsidized.

Many companies went into the business and at one time there were more than 100 firms, with an estimated capital of about $7,500,000. But many of these new enterprises proved short lived. Of the 72 firms reported as manufacturers in the spring of 1920, 46 had discontinued by the end of July. The number making sulphur colors was reduced from 33 to 7. Those firms still operating are reported to be working only part time. It is reported that the range of dyes now made in Japan includes direct cotton dyes, basics, and mordants, oxidized colors and sulphurs. The Mitsui Mining Co. is making various anthracene colors and synthetic indigo. The Japan Color Co. produces Sulphur Blacks, which have been exported chiefly to China.

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[1] British Trade Journal, May 9, 1918.

art III. CENSUS OF DYES IMPORTED INTO THE UNITED STATES FROM JULY 1, 1919, TO JUNE 30, 1920.

Section 501 of Title V of the act of September 8, 1916, makes the pecific duties on dyes and other finished coal-tar products after eptember 8, 1921, dependent upon whether as much as 60 per cent of the consumption of these products is being produced in the United States. Unfortunately, however, the provisions are not clear as to whether the domestic consumption is to be considered as the total consumption of each class of finished products or the consumption of individual items within the class. In either case there has been a lack of detailed information as to the importation of individual dyes, and therefore a census of imports was undertaken by the Tariff Commission.

With the cooperation of the Treasury Department all invoices covering dye imports in the fiscal year 1920, with the exception of those of the port of New York, were sent to the commission for tabulation. The statistics of dyes imported through the port of New York were obtained by transcribing the necessary information direct from the invoices in the customshouse files of the collector of the port of New York.

The dyes were classified according to their chemical composition and were tabulated according to the Schultz and Julius Tables, 1914 edition. Various dyes were also identified according to Norton's census[1] as well, and from other sources of information in the files of the Tariff Commission. Dyes identified by Norton as a, b, c classes under a given Schultz number were included in that number in each case without special designation, although it is understood that such dyes are not always chemically identical with the original Schultz types.

The Tariff Commission can not vouch for the accuracy of these classifications, as some identifications were supplied by dye experts and others by foreign manufacturers. Those dyes which could not be identified by Schultz numbers were classified according to their method of application as follows: Direct, vat (including indigo), acid, sulphur, mordant and chrome, basic and oil-soluble dyes. A small number of colors not classified by either method are listed by name under the heading "unidentified and unclassified colors." In

[1] Norton, Thomas H.: "Artificial Dyestuffs Used in the United States," Dept. of Commerce, Sp. Agts. Series No. 121.

addition, 9,352 pounds of dyes are included in "all other," as t trade or chemical name for the dyes was not given in the invoices.

The published values of English dyes include c. i. f. charges, wit the exception of a small charge for packing. In the case of Swi dyes, however, all extra charges are included in every instan The German invoices varied in the methods used, but in most ca the extra charges are not included in the invoice values.

The date of the consular certification was taken as a basis in con verting the foreign invoice value to United States currency. Th rate of exchange used as a basis in conversions was the exchan value published by the Treasury Department for that quarter i which the consular certification dates occurred.

SYMBOLS DENOTING MANUFACTURER.

In the table of imports of dyes under the heading "manufacturer" is shown a symbol for each dye, which refers to the following list o manufacturers in foreign countries.

1. THE SIX LEADING COMPANIES.

A_____Actien-Gesellschaft fur Anilin-Fabrikation, Berlin. Founded 187 Branches in France and Russia.

B_____Badische Anilin- und Soda-Fabrik, Ludwigshafen on the Rhi Founded 1865. Branches in France and Russia.

By_____Farbenfabriken vorm. Firedr. Bayer & Co., Leverkusen on the Rh Founded 1862. Branches in France, Russia, and the United St (Rensselaer, N. Y.).

C_____Leopold Cassella & Co., Frankfort on the Main. Founded 187 Branches in France and Russia.

K_____Kalle & Co., A. G., Biebrich on the Rhine. Founded 1870. Branch Russia.

M_____Farbwerke vorm. Meister Lucius & Brüning, Hochst on the Ma Founded 1862. Branches in France and Russia.

2. THE SEVEN SMALLER GERMAN COMPANIES.

BK_____Leipziger Anilinfabrik Beyer & Kegel, Furstenberg near Leip Founded 1882.

CG_____Chemikalienwerk Griesheim G. m. b. H., Griesheim on the Ma Founded 1881.

CJ_____Carl Jäger G. m. b. H., Anilinfarbenfabrik, Dusseldorf. Founded 18

GrE____Chemische Fabrik Griesheim-Elektron, Offenbach on the Ma Founded 1842.

L_____Farbwerk Muhlheim vorm. A. Leonhardt & Co., Muhlheim on the Ma Founded 1879. Branch in France.

tM_____Chemische Fabriken vorm. Weiler ter Meer, Uerdingen on the Rhine Founded 1877.

WD____Wülfing, Dahl & Co., A.-G. Barmen. Founded 1842.

3. DUTCH, BELGIAN, AND FRENCH COMPANIES.

FA_____Farbwerk Ammersfoort, Amnersfoort, Netherlands. Founded 1888.
NF_____Niederlandische Farben- und Chemikalienfabrik Delft, Delft, Netherlands. Founded 1897. Branch in Russia.
LG_____Lazard Godchaux, of Brussels. (These products are probably compounded largely from the dyes made by A. Wiescher & Co., of Haeren, Belgium.)
P_____Societe Anonyme des Matieres colorantes et produits chimiques St. Denis (formerly A. Poirrier), St. Denis, near Paris, France. Founded 1830.

4. SWISS COMPANIES, ALL AT BASEL.

DH_____Farbwerke vorm. L. Durand, Huguenin & Co. Founded 1871. Branches in Germany and France.
G_____Anilinfarben- und Extract-Fabriken vorm. Joh. Rud. Geigy. Founded 1764. Branches in France, Germany, and Russia.
I_____Gesellschaft fur chemische Industrie. Founded 1885. Branch in France.
S_____Chemische Fabrik vorm. Sandoz & Co. Founded 1887.

5. ENGLISH COMPANIES.

ClCo____The Clayton Aniline Co. (Ltd.), Clayton, near Manchester. Founded 1876.
CR_____Clauss & Co. (formerly Clauss & Ree), Clayton, near Manchester. Founded 1890.
CV_____Colne Vale Chemical Co., Milnsbridge, near Huddersfield.
RHS____Read Holliday & Sons (Ltd.), Huddersfield. Founded 1830. (Purchased by British Dyes (Ltd.).)
BD_____British Dyes (Ltd.). Founded 1915.
Lev_____Levinstein (Ltd.), Crumpsall Vale, near Manchester. Founded 1864.
Q_____Importations of unknown source, through dealers in colors.

TABLE 13.—*Summary of dyes imported into the United States during the fiscal year 1920, classified by application.*

Class.	Quantity.	Per cent of total.
	Pounds.	
Direct	694,757	19.8
Vat (including indigo)	942,145	26.9
(*a*) Indigo	520,347	14.9
(*b*) Other vats	421,798	12.0
Acid	851,220	24.3
Sulphur	276,800	7.9
Mordant and chrome	447,869	12.7
Basic	230,529	6.7
Dyes for color lakes and spirit soluble dyes	15,516	.4
Unclassified	42,311	1.3
Total	3,501,147	100.0

TABLE 14.—*Imports of dyes for fiscal year 1920*—Continued.

Schultz No.	Name of dye.	Manufacturer.	Imports.	
			Quantity.	Invoice value
			Pounds.	
671	Induline scarlet	B	77	
672	Azo carmine GX		330	43.
	Rosazine	S		
	Rosazine conc	S		
673	Azo carmine B		404	
	Rosinduline 2B bluish	K		
679	Safranine		386	
	Safranine FF extra	LG		
681	New fast gray		50	
	Methylene gray ND	M		
684	Brilliant rhoduline red B	By	24	
685	Tannin heliotrope	C	249	
687	Rosolane O	M	42	
	Rosolane B conc	M		
690	Diphene blue R	A	541	
692	Naphtazine blue		2,249	
	Napthazine navy blue	WD		
699	Induline (water soluble)		100	
	Soluble blue 2R	BD		
705	Indamine 6R		5,675	4,
	Acid cyanine BF	A		
	Acid cyanine BF	LG		
	Indocyanine B	A		
709	Pyrogene green 2G		5,005	5,
	Pyrogene dark green yellow B shade	I		
	Pyrogene green 3G	I		
734	Pyrogene yellow		3,307	
	Pyrogene yellow O	I		
736	Katigene green		11,855	17,
	Thional brilliant green GG	S		
	Thional brilliant green G	S		
747	Thional red brown		25,078	8,
	Thional brown G	S		
	Thional brown GD	BD		
748	Hydron blue		21,593	8,
	Carbindol blue R	Lev		
	Hydron blue G paste 20 per cent	C		
	Hydron blue G paste 30 per cent	C		
	Hydron blue G paste 40 per cent	C		
	Hydron blue G powder	C		
	Hydron blue R paste 20 per cent	C		
	Hydron blue R powder	C		
759	Anthraflavone G paste	B	1,353	2
	Anthraflavone GC paste	B		
760	Indanthrene golden orange G paste	B	2,837	3,
	Indanthrene golden orange G powder			
	Indanthrene golden orange G double paste			
	Indanthrene golden orange G double paste, sand free			
761	Indanthrene golden orange R paste	B	15,208	28,
	Indanthrene golden orange R paste, sand free	B		
	Indanthrene golden orange RRT paste	B		
	Indanthrene golden orange RRT paste, sand free	B		
	Indanthrene golden orange R double paste, sand free	B		
762	Indanthrene scarlet G paste	B	395	2
	Indanthrene scarlet G paste, sand free	B		
	Indanthrene scarlet G double paste	B		
	Indanthrene scarlet G double paste, sand free	B		
763	Indanthrene dark blue BO paste, sand free	B	906	1
	Indanthrene dark blue B.O.S. powder	B		
765	Indanthrene green B paste	B	3,427	1,
	Indanthrene green B powder	B		
	Indanthrene green B double paste	B		
	Indanthrene green B double paste, sand free	B		
766	Indanthrene violet R ex. paste	B	842	2
	Indanthrene violet R ex. paste, sand free	B		
767	Indanthrene violet RR extra	B	11,198	24,
	Indanthrene violet RR extra paste	B		
	Indanthrene violet RR extra paste, sand free	B		
	Indanthrene violet RR extra powder	B		
	Indanthrene violet RR extra double paste, sand free	B		
768	Indanthrene black BB double paste	B	25,027	40,
	Indanthrene black BB powder	B		
772	Galloflavine 10 per cent paste	B	24	
774	Alizarin black S paste	B	14,703	1,
	Alizarin black WR 16 per cent paste	B		

TABLE 14.—*Imports of dyes for fiscal year 1920*—Continued.

Schultz No.	Name of dye.	Manufacturer.	Imports.	
			Quantity.	Invoice value.
			Pounds.	
778	Alizarin (synthetic)		8,575	$2,762
	Alizarin paste YCA 20 per cent	Q		
	Alizarin red paste IP 20 per cent	Q		
	Alizarin red paste YCA	Q		
	Alizarin red IB 20 per cent paste	M		
	Alizarin red IB 40 per cent paste	M		
779	Alizarin orange R paste	By	500	
780	Alizarin red		5,072	1,524
	Alizarin red 1 WS	M		
	Alizarin red S powder	B		
	Alizarin red SWB powder	B		
	Alizarin red W powder	By		
782	Alizarin brown		1,235	450
	Anthracene brown 20 per cent	B		
	Anthracene brown 100 per cent powder	B		
	Anthracene brown WL paste	Lev		
	Alizarin brown G	M		
	Alizarin brown 20 per cent paste	M		
	Anthracene brown WLP paste	Lev		
784	Alizarin SX		2,289	818
	Alizarin paste SX 20 per cent	Q		
	Alizarin GX 20 per cent paste	B		
787	Alizarin Bordeaux GG paste	By	20	
	[Mixture with 778.]			
788	Alizarin cyanine NS powder	By	187	92
	Alizarine cyanine WRB powder			
789	Anthracene blue WR paste	B	29,608	32,114
	Anthracene blue WR paste double	B		
790	Anthracene blue SWGG powder	B	856	939
	Anthracene blue SWGG powder	B		
	Anthracene blue SWGG ex powder	B		
	Anthracene blue SWR powder	B		
	Anthracene blue SWB powder	B		
791	Indanthrene olive G powder	B	11	
792	Cibanone orange R		6,188	11,610
	Cibanone green G paste	I		
	Cibanone orange R paste	I		
	Cibanone orange R paste 9 per cent	I		
	Cibanone orange R paste 7 per cent	I		
	Cibanone orange R paste 8 per cent (yellow shade)	I		
	Cibanone orange R paste 10 per cent	I		
795	Cibanone yellow R paste 10 per cent		15,886	21,488
	Cibanone yellow R paste	I		
	Cibanone yellow R paste	S		
	Cibanone yellow R paste 10 per cent	I		
798	Alizarin maroon paste, 10 per cent	B	70	
799	Alizarin cyanine GG powder	By	3,165	10,958
	Alizarin cyanine green G extra powder	By		
800	Anthracene blue WG paste	B	49	
803	Alizarin blue WX 10 per cent paste	B	2,031	144
	Alizarin blue JR powder	By		
804	Alizarin blue S		12,298	8,527
	Alizarin blue SB 45	M		
	Alizarin blue S powder	By		
	Alizarin blue S powder	B		
	Alizarin sky blue B conc. 70/100 powder	By		
	Alizarin sky blue B powder	By		
	Alizarin blue SB 45 conc. 50 per cent	M		
808	Alizarin green S paste	B	2,997	
810	Helindone yellow 3 GN		1,440	3,751
	Helindone yellow CG	M		
	Helindone yellow CAK powder and paste	M		
	Helindone yellow 3GN paste and powder	M		
	Helindone yellow 3GN	M		
811	Algole yellow 3GL paste	By	440	112
	Algole yellow 3 G powder	By		
	Algole yellow 3 G L powder	By		
812	Indanthrene orange RT	B	382	43
	Indanthrene orange RT paste	B		
814	Algole yellow WF	By	3	
815	Algole scarlet G paste	By	552	1,547
	Algole scarlet G powder	By		
816	Algole red 5G paste	By	146	21
	Algole red 5G powder			
	Algole yellow 3G paste			
817	Algole yellow R powder	By	801	

TABLE 14.—*Imports of dyes for fiscal year 1920*—Continued.

Schultz No.	Name of dye.	Manufacturer.	Imports.	
			Quantity.	Invoice value
			Pounds.	
818	Algole pink R paste	By	1,113	$
	Algole pink R powder	By		
819	Algole red FF extra paste	By	2,910	
	Algole red FF extra powder	By		
	Algole brilliant red 2B paste	By		
	Algole red R extra paste	By		
	Algole red R extra powder	By		
820	Algole brilliant violet R paste	By	3,016	
	Algole brilliant violet RP powder	By		
821	Algole brilliant violet 2B paste	By	556	
	Algole brilliant violet 2B powder	By		
	Algole blue 3R paste	By		
	Algole blue 3R powder	By		
822	Algole brilliant orange FR paste	By	449	
	Algole brilliant orange FR powder	By		
823	Algole violet B powder	By	29	
824	Algole orange R paste	By	373	
	Algole orange R powder	By		
825	Algole red B paste	By	3,552	
	Algole red B powder	By		
828	Indanthrene claret B paste	B	2,721	
	Indanthrene claret B extra paste	B		
829	Algole bordeaux 3B paste	By	61	
	Algole bordeaux 3B powder	By		
830	Indanthrene red R paste	B	1,538	
	Indanthrene red R powder	B		
	Indanthrene red R double paste	B		
	Indanthrene red R double powder	B		
	Indanthrene red R double paste, sand free	B		
831	Indanthrene red BN extra paste	B	2,916	
	Indanthrene red BN extra paste, sand free	B		
	Indanthrene red BN extra powder	B		
	Indanthrene violet RN extra powder	B		
833	Algole olive R paste	By	461	
	Algole olive R powder	By		
834	Algole gray B powder	By	101	
	Algole gray 2B powder	By		
835	Helindone orange GRN		10,010	
	Helindone orange GRN paste	M		
836	Helindone brown 3GN paste	M	15,000	
838	Indanthrene blue RS	B	8,144	
	Indanthrene blue RS for paper paste	B		
	Indanthrene blue RS for paper trip. powder	B		
	Indanthrene blue RS paste	B		
	Indanthrene blue RS double paste	B		
	Indanthrene blue RS paper paste, sand free	B		
	Indanthrene blue RS trip. paper	B		
839	Algole blue K powder	By	124	
840	Indanthrene blue 3G powder	B	551	
	Indanthrene blue 3G paste	B		
842	Indanthrene blue GCD paste	B	54,478	
	Indanthrene blue GCD paste, sand free	B		
	Indanthrene blue GCD powder	B		
	Indanthrene blue GCD double paste	B		
	Indanthrene blue GCD double paste, sand free	B		
844	Algole blue 3G paste	By	2,079	
845	Indanthrene maroon R paste	B	46	
847	Algole green B paste	By	339	
	Algole green B powder	By		
	Algole dark green B powder	By		
848	Indanthrene gray B paste	B	1,949	
	Indanthrene gray B powder	B		
	Indanthrene gray B double paste	B		
	Indanthrene gray B double paste, sand free	B		
849	Indanthrene yellow G double paste	B	22,812	
	Indanthrene yellow G paste	B		
	Indanthrene yellow G paste, sand free	B		
	Indanthrene yellow R paste double	B		
	Indanthrene yellow R paste	B		
	Indanthrene yellow R paste, sand free	B		
	Indanthrene yellow R double paste, sand free	B		
	Indanthrene yellow powder	B		
850	Indanthrene blue WB powder	B	1,499	
851	Alizarin direct blue B		213	
	Alizarin cyanole B	C		
	Alizarin direct blue B	M		
	Alizarin direct blue EB	M		

TABLE 14.—*Imports of dyes for fiscal year 1920*—Continued.

Schultz No.	Name of dye.	Manufacturer.	Imports.	
			Quantity.	Invoice value.
			Pounds.	
852	Alizarin irisol DR		251	$481
	Alizarin direct violet R	M		
	Alizarin irisole R powder	By		
853	Anthraquinone violet powder	B	750	
854	Alizarin viridine FF paste	By	4,422	3,523
	Alizarin viridine FF powder	By		
	Alizarin viridine F paste	By		
856	Alizarin astrole B powder	By	5,795	16,603
	Alizarin rubinole 3G powder	By		
	Alizarin rubinole R conc. 50/100 powder	By		
	Alizarin rubinole R powder	By		
858	Alizarin sapphirole B powder	By	22,890	25,732
	Alizarin sapphirole SE powder	By		
	Alizarin sapphirole WSA powder	By		
859	Cyananthrol R powder	B	529	5,557
	Cyananthrol RBX	B		
	Cyananthrol RXO	B		
862	Alizarin blue black B powder	By	16,884	17,624
	Alizarin blue black 3B powder	By		
863	Anthraquinone blue green BXO	B	99	
864	Anthraquinone green GXN	B	98	
865	Alizarin direct green G		10,818	23,297
	Alizarin direct green GC	M		
	Alizarin cyanine green E powder	By		
	Alizarin cyanine green G extra conc 70/100 powder	By		
	Alizarin cyanine green G extra powder	By		
	Alizarin direct green G	M		
866	Leuco dark green B powder	By	60	
867	Indanthrene brown B double paste	B	1,676	150
	Indanthrene brown B powder	B		
	Indanthrene brown B paste sand free	B		
869	Algole brown R paste	By	2,657	6,554
	Algole brown R powder	By		
870	Algole Corinth R powder	By	88	597
	Algole Corinth R powder	By		
873	Helindone brown AN		2,857	3,694
	Helindone brown AN 10 per cent paste	Q		
	Indanthrene pink B paste	B		
	Indanthrene pink B paste sand free	B		
	Indanthrene pink BL powder	B		
	Indanthrene red violet RRN paste	B		
	Indanthrene red violet RRN powder	B		
874	Indigo (synthetic)		520,347	351,440
877	Indigotine or indigo extract		5,512	3,810
	Indigotine 05120	WD		
	Indigotine conc	WD		
880	Indigo RB		3,945	2,215
	Helindone blue BB paste	M		
	Indigo MLB 2B powder	M		
	Indigo MLB 2B paste 20 per cent	M		
	Helindone blue BB paste	M		
881	Brom-indigo		49,646	89,670
	Ciba blue 2B powder	S		
	Ciba blue 2B powder	I		
	Ciba blue 2BD paste 16 per cent	I		
	Ciba blue 2BD paste	I		
	Ciba blue 2B	I		
	Brom-indigo FB powder	By		
	Indigo MLB 4B 20 per cent	M		
883	Indigo KG		1,467	2,405
	Indigo MLB 6B powder	M		
	Indigo MLB 6B paste	M		
	Indigo MLB 6B paste, 40 per cent	M		
885	Brilliant indigo B, 20 per cent	B	3,502	1,624
	Brilliant indigo B powder	B		
	Brilliant indigo B paste 20 per cent	B		
887	Brilliant indigo 4G, 20 per cent	B	501	351
	Brilliant indigo 4G paste 20 per cent	B		
888	Indigo G paste	B	452	
892	Helindone green G		796	4,779
	Helindone green G paste	M		
	Helindone green G powder	M		
893	Alizarin indigo G paste	By	795	
894	Alizarin indigo B paste	By	291	
895	Alizarin indigo 3 R paste	By	1,673	322
	Alizarin indigo 3 R powder	By		

TABLE 14.—*Imports of dyes for fiscal year 1920*—Continued.

UNIDENTIFIED DIRECT DYES—Continued.

Schultz No.	Name of dye.	Manufacturer.	Imports	
			Quantity.	Invoice value.
			Pounds.	
	Alkali pink G	WD	510	$101
	Alkali pink B	WD		
	Alkali rubin G conc. 300 per cent	WD	1,675	
	Alkali scarlet	WD	322	
	Aminogene base RN	I	661	
	Aminogene blue RN	I	1,942	
	Benzamine azo blue G conc. 350 per cent	WD	2,197	1,467
	Benzamine azo blue 3R conc. 215 per cent	WD		
	Benzamine fast yellow 2G conc. 200 per cent	WD	220	
	Benzamine violet C	WD	236	
	Benzo Bordeaux 6B	By	1,149	
	Benzo chrome brown G	By	2,398	
	Benzo chrome brown CR	By	104	
	Benzo fast black	LG	1,572	1,439
	Benzo fast black	By		
	Benzo fast black L	By	3,377	
	Benzo fast blue FFL	By	299	
	Benzo fast blue G	By	800	
	Benzo fast Bordeaux 6BL	By	1,226	
	Benzo fast brown 3GL	By	176	
	Benzo fast eosine BL	By	99	
	Benzo fast heliotrope BL	By	1,312	
	Benzo fast heliotrope 4BL	By	112	
	Benzo fast heliotrope 2RL	By	703	
	Benzo fast orange S	By	450	
	Benzo fast scarlet 4BA	By	201	
	Benzo red 12B	By	600	
	Benzo rhoduline 3B	By	97	
	Benzo rhoduline red B	By	150	
	Benzoin black	BK	1,764	
	Benzoin blue black RH 150 per cent	BK	287	
	Brilliant benzo green B	By	225	
	Brilliant benzo violet B	By	351	
	Brilliant benzo violet 2R	By	24	
	Brilliant fast blue B	By	450	
	Brilliant fast blue B conc. 50/100	By	201	
	Brilliant fast blue 2G	By	100	
	Brilliant fast blue 2G conc. 60/100	By	242	
	Chicago red III	G	2,205	
	Chloramine black	S	672	855
	Chloramine black HW	S		
	Chloramine black EX conc	S		
	Chloramine brilliant red 8B	S	21,796	81,419
	Chloramine brilliant red 8B conc	S		
	Chloramine brown 2R	S	1,102	
	Chloramine fast red F	S	550	
	Chloramine pink R	BD	625	1,569
	Chlorazol pink R	RHS		
	Chlorazol pink R	BD		
	Chloramine red 8BS	By	7,237	
	Chloramine violet R	By	397	
	Chloramine violet WBX	BD	1,052	1,397
	Chlorazol violet WBX	BD		
	Chloramine red BII	S	220	
	Chlorazol brown G	BD	8,962	
	Chlorazol green B	BD	256	
	Chlorazol dark green PL	BD	10,098	9,893
	Chlorazol green	BD		
	Chloramine dark green PL	BD		
	Chlorazol dark green PO	BD	1,028	
	Chlorazol sky blue FFS	BD	40	
	Columbia brown RK	A	200	
	Congo brilliant R	S	220	
	Cotton blue 11 double	M	1,102	
	Cotton yellow GI	B	291	
	Cupranite brown G	I	500	
	Cutch brown 2R	S	7,715	
	Diamine azo blue R	C	51	
	Diamine Bordeaux S	C	626	
	Diamine catechine B	C	417	
	Diamine fast blue FFB	C	2,919	

TABLE 14.—*Imports of dyes for fiscal year 1920*—Continued.

UNIDENTIFIED DIRECT DYES—Continued.

Schultz No.	Name of dye.	Manufacturer.	Imported: Quantity	Imported: Value
			Pounds	
	Diamine fast brown G	C	2,6[illegible]	
	Diamine fast brown R	C		
	Diamine fast gray BN	C	3,171	
	Diamine fast gray BN	Q		
	Diamine fast gray G	Q		
	Diamine fast gray G	C		
	Diamine fast Bordeaux 6BS	C	99	
	Diamine fast Bordeaux	C	73	
	Diamine fast orange EG	C	99	
	Diamine fast scarlet 10BF	C	157	
	Diamine fast scarlet GG	C	9	
	Diamine fast scarlet 8BN	C	64	
	Diamine fast violet FFBN	C	13	
	Diamine orange F	C	1,100	
	Diamine orange B	C		
	Diamine orange G	C		
	Diamine scarlet B	C	137	
	Diamine sky-blue FF	C	25	
	Diamine violet red	C	2	
	Diamine violet red K extra	C	37	
	Diamineral blue CVB	C	51	
	Dianil light red 8BW	M	4	
	Dianol black FFX	BD	1,680	
	Dianol dark blue B	BD	23,436	
	Dianol dark blue B	Lev		
	Dianol fast blue 2B	Lev	4,034	
	Dianol fast blue G	BD	840	
	Dianol fast blue RB	BD	1,814	
	Dianol fast blue RB	Lev		
	Dianol fast pink BK	BD	7,342	
	Dianol fast pink BK	Lev		
	Dianol fast red K	BD	120	
	Dianol fast yellow ARX	Lev	4,475	
	Dianol fast yellow ARX	BD		
	Dianol orange brown X	BD	5,064	
	Dianol violet R	BD	5,490	
	Dianol violet R	Lev		
	Diazanil blue BB	M	18	
	Diazenil pink B	M	543	
	Diazo Bordeaux 7B	By	181	
	Diazo brilliant green 3G	By	2	
	Diazo brilliant orange GR extra	By	4	
	Diazo brilliant orange 5G extra	By	4	
	Diazo brilliant scarlet B extra	By	194	
	Diazo brilliant scarlet 2BL extra conc	By	818	
	Diazo brilliant scarlet 5BL extra	By	21	
	Diazo brown 3G	By	289	
	Diazo brilliant scarlet 3B extra	By	284	
	Diazo brilliant scarlet 6B extra	By	308	
	Diazo brilliant scarlet G extra	By	317	
	Diazo brown 3G	By	212	
	Diazo brown 3RB	By	4	
	Diazo fast bordeaux BL	By	220	
	Diazo fast red 5BL	By	11	
	Diazo fast violet BL	By	143	
	Diazo sky-blue 3G	By	443	
	Diazo fast red 7BL	By	509	
	Diazo fast violet BL	By	88	
	Diazo fast yellow G	By	119	
	Diazo fast yellow 2G	By	9	
	Diazo fast yellow 3RL	By	2	
	Diazo geranine B extra	By	511	
	Diazo indigo blue 4GL extra	By	161	
	Diazo olive G	By	4	
	Diazo rubine B	By	606	
	Diazo rubine B conc., 60/100	By	99	
	Diazo sky-blue	By	11	
	Diazo sky-blue 3G	By	953	
	Diazo violet BL	By	2	
	Diazo yellow R	By	2	
	Diphene blue R	A	459	
	Diphenyl blue KFC	G	1,587	
	Diphenyl violet BVC	G	220	
	Direct black B conc	Q	200	
	Direct blue BXR	S	2,863	
	Direct brown G	CG	1,087	

TABLE 14.—*Imports of dyes for fiscal year 1920*—Continued.

UNIDENTIFIED DIRECT DYES—Continued.

Ault z No.	Name of dye.	Manufacturer.	Imports.	
			Quantity.	Invoice value.
			Pounds.	
	Direct brown 3GNC	S	661	
	Direct brown R	CG	2,204	
	Direct fast yellow CR	Q	1,729	
	Direct fast yellow GR	Q	2,855	
	Direct green	CG	7,760	$3,540
	Direct green B	CG		
	Direct sky-blue green shade	I	2,002	
	Direct violet B	S	1,961	
	Direct violet R, 360 per cent	CG	1,243	
	Heligoland black FFNA	CG	21,089	10,454
	Heligoland black FFN extra	CG		
	Heligoland black BH 100 per cent	CG		
	Heligoland blue 6B	CG	9,951	
	Naphtamine fast green B	K	325	
	Naphtogene blue BM	A	731	
	Naphtogene blue 2R	A	2,221	
	Naphtogene blue 4R	A	126	
	New yellow for cotton, 333 per cent	WD	3,968	3,724
	New yellow for cotton, 335 per cent	WD		
	New yellow for cotton	WD		
	Oxamine yellow 3G	B	40	
	Oxydiamine brown G	C	201	
	Oxydiamine brown RN	C	2	
	Oxydiaminogen ED	C	24	
	Oxydiaminogene OB	C	500	
	Polyphenyl blue GNH conc	G	463	
	Polyphenyl orange RC	G	908	1,03[illegible]
	Polyphenyl orange SP	G		
	Polyphenyl yellow RC	G	1,179	
	Pyrazol brown G	S	1,984	
	Pyrazol orange G	S	25,078	
	Rosanthrene Bordeaux B	I	500	
	Rosanthrene R	S	1,773	3,[illegible]
	Rosanthrene R paste	S		
	Rosanthrene R	I		
	Solomine blue FF	LG	[illegible]	
	Thional yellow B	S	4[illegible]3	
	Toluylene fast orange GL	LG	597	
	Toluylene yellow G	By	20	
	Triazol Bordeaux B	GrE	65	
	Triazol brown 8000	GrE	2	
	Trisulphone bronze B	S	972	
	Zambesi black D extra		18,962	17,[illegible]
	Zambesi black D extra	LG		
	Zambesi black D	A		
	Zambesi black V	A		
	Zambesi black V	LG		

UNIDENTIFIED VAT COLORS.

	Algole brown G powder	By	12[illegible]	
	Algole yellow 3GL powder	By	[illegible]3	
	Caledon blue R	Q	2[illegible]	
	Chloranthrene Bordeaux B paste	BD	1[illegible]	
	Chloranthrene red 5G	BD	[illegible]4	
	Cibanone green B paste 10 per cent	I	2,524	$[illegible]
	Cibanone green B paste	I		
	Cibanone green B	S		
	Durindone blue 4B	BD	4,512	[illegible],1[illegible]2
	Durindone blue 5B	BD		
	Durindone blue 5B	Lev		
	Durindone blue 6B	BD		
	Durindone blue 6B	Lev		
	Durindone blue 4B extra	Lev		
	Durindone red B	Lev	12[illegible]	
	Durindone scarlet R	BD	1,9[illegible]	
	Durindone scarlet R	Lev		
	Helindone black 2RG paste (for printing)	M	2[illegible]	
	Helindone black paste (for printing)	M		
	Helindone fast scarlet B powder	M	[illegible]	
	Indanthrene bluish green BN paste, sand free	B	1[illegible]	

TABLE 14.—*Imports of dyes for fiscal year 1920*—Continued.

UNIDENTIFIED VAT COLORS—Continued.

Schultz No.	Name of dye.	Manufacturer.	Imported: Quantity.	Imported: Invoice value.
			Pounds.	
	Indanthrene blue RC powder	B	51	
	Indanthrene brown RR paste	B	[illegible]	
	Indanthrene brown RR	B	[illegible]	
	Indanthrene violet BN extra paste	B	3,[illegible]	[illegible]
	Indanthrene violet BN extra paste, sand free	B		
	Indanthrene violet RRN paste, sand free	B		
	Vat violet R paste	Q	[illegible]	
	Vat yellow R paste	Q	440	

UNIDENTIFIED ACID COLORS.

	Acetyl red BB	B	[illegible]
	Acid blue RBF	I	30
	Acid Bordeaux	S	220
	Acid brilliant blue A	LG	5[illegible]
	Acid green	Q	26
	Acid green 40 per cent	Q	
	Acid milling black B	G	1,146
	Acid rhodamine BG	B	51
	Acid rhodamine R	B	4
	Acid rhodamine	I	330
	Acid violet 4RN	B	2
	Acid violet 6B	LG	[illegible]
	Acid violet R extra conc	WD	[illegible]
	Alkali blue 2G	M	329
	Alkali blue 2R 1918	M	207
	Alkali fast green 3B	By	336
	Alkali fast green 3G	By	300
	Anthracyanine 3FL		436
	Anthracyanine 3FL	LG	
	Anthracyanine 3FL	By	
	Anthracyanine 3FL conc., 40/100	By	
	Anthracyanine FL conc., 50/100	By	
	Anthracyanine 3 FL reddish	LG	
	Anthracyanine S powder	DH	1,102
	Anthosine 5B	B	22
	Azo acid blue B	S	220
	Azo crimson L	By	249
	Azo dark green A	G	485
	Azo geranine 3BN	BD	4,480
	Azo geranine 3BN	Lev	
	Azo rhodine	S	2,811
	Azo rhodine 6B	S	
	Azo rhodine 2G	S	
	Azo rhodine 2GN	S	
	Azorubin 2B conc. 160 per cent	WD	6,680
	Azo wool violet 7R	C	99
	Brilliant acid blue CB	By	110
	Brilliant acid carmine 6B	Gr. E	99
	Brilliant anthrazurol	B	11
	Brilliant fast red L 125 per cent	BK	165
	Brilliant milling red R	C	99
	Brilliant scarlet 4R conc	WD	11,179
	Brilliant scarlet RN	WD	
	Brilliant scarlet PHT	WD	
	Brilliant silk blue 10B	A	11
	Brilliant sulphone red 10B	S	664
	Calcutta blue	S	43,857
	Cochineal B extra	G	214
	Coomassie fast black BW	BD	10,080
	Coomassie fast black BW	Lev	
	Cyananthrol BGA	B	75
	Cyananthrol BGA00	B	40
	Cyananthrol R	B	26
	Cyananthrol RBX powder	B	165
	Cyananthrol RXO	B	602
	Double scarlet S conc. 115 per cent	WD	1,477
	Eosine L paste	B	146
	Fast acid eosine G extra	M	4,361
	Formyl blue BX	C	213
	Erio fast fuchsine BBL	G	1,654
	Erio flavine SX	G	2,535

TABLE 14.—*Imports of dyes for fiscal year 1920*—Continued.

UNIDENTIFIED ACID COLORS—Continued.

Schultz No.	Name of dye.	Manufacturer.	Imports.	
			Quantity.	Invoice value.
			Pounds.	
	Erio green B conc	G	6,856	$36,151
	Erio green B supra	G		
	Erio violet BC	G	7,914	14,859
	Erio violet AL supra	G		
	Erio violet RL supra	G		
	Fast acid green BB extra	M	1,100	
	Fast cyanine Navy blue extra conc	WD	1,102	
	Fast light blue B	WD	187	
	Fast light yellow	WD	1,102	
	Fast red AN conc. 135 per cent	WD	2,569	24,595
	Fast red V	Q		
	Fast blue wool BL	LG	3,857	2,977
	Fast wool blue R	LG		
	Green 21	S	441	
	Guinea fast green B	A	500	
	Guinea fast red 2R	A	100	
	Jasmine high conc	G	4,189	
	Jersey black B	Q	100	
	Kiton fast violet 10B	S	661	1,446
	Kiton fast violet 10B	I		
	Kiton fast yellow S	I	642	894
	Kiton yellow S	I		
	Milling red 4BA	A	100	
	Milling yellow 3G	C	15	
	Milling yellow 3G, 200 per cent	C	243	
	Milling yellow O	C	11	
	Milling yellow OO	C	60	
	Naphthalene black 12B	BD	6,110	
	Naphthalene blue B	M	110	
	Naphthylamine blue black	CG	6,658	
	Navy blueA	I	225	363
	Navy blue	Q		
	New acid brown	Lev	60	
	Palatin light yellow R	B	62	
	Patent blue E	M	300	
	Pink M	BD	25	
	Polar red G conc	G	1,543	
	Resorcin havana brown	BK	441	
	Rosinduline GXF	K	20	
	Special blue G	B	82	
	Sulphone blue R	LG	3,022	
	Victoria navy blue B	By	522	
	Wool blue RL	G	2,866	
	Wool blue S conc. 333 per cent	WD	1,489	
	Wool brown	WD	441	
	Wool fast violet B, conc. 50/100	By	55	
	Wool green NB	Q	3,292	
	Wool violet R	K	94	
	Xylene fast green B	S	1,720	

UNIDENTIFIED SULPHUR COLORS.

Cross dye green B	BD	16,274	
Cross dye green 2G conc	BD	7,056	$9,429
Cross dye green 2G	BD		
Cross dye yellow Y	BD	4,480	
Eclipse brown BK	G	5,952	
Hydrosulphon green S	Q	500	
Immedial olive B	C	201	
Immedial purple C	C	4	
Immedial direct blue B	C	450	
Pyrogene yellow O	I	2,205	
Sulphur blue	Q	300	299
Sulphur blue extra	Q		
Sulphur brown	Q	300	135
Sulphur brown conc	Q		
Sulphur cutch	Q	400	
Sulphur green	Q	200	
Sulphur green B	BD	3,178	
Sulphur indigo	Q	100	
Sulphur yellow	Q	3,600	1,267
Sulphur yellow	BD		

TABLE 14.—*Imports of dyes for fiscal year 1920*—Continued.

Schultz No.	Name of dye	Manufacturer.	Imports. Quantity.	Imports. Invoice value.
			Pounds.	
818		By	1,113	[illegible]
		By		
819		By	2,910	[illegible]
		By		
		By		
		By		
		By		
820		By	[illegible]	[illegible]
		By		
821		By	558	2,[illegible]
		By		
		By		
		By		
822		By	449	510
		By		
823		By	29	
824		By	373	[illegible]
		By		
825		By	3,552	5,477
		By		
828		B	2,721	[illegible]
		B		
829		By	61	[illegible]
		By		
830		B	1,538	[illegible]
		B		
	Indanthrene red R double paste	B		
	Indanthrene red R double powder	B		
	Indanthrene red R double paste, sand free	B		
831	Indanthrene red BN extra paste	B	2,910	1,466
	Indanthrene red BN extra paste, sand free	B		
	Indanthrene red BN extra powder	B		
	Indanthrene violet RN extra powder	B		
833	Algole olive R paste	By	461	[illegible]
	Algole olive R powder	By		
834	Algole gray B powder	By	101	[illegible]
	Algole gray 2B powder	By		
835	Helindone orange GRN		10,000	
	Helindone orange GRN paste	M		
836	Helindone brown 3GN paste	M	15,000	4,3[illegible]
838	Indanthrene blue RS	B	8,144	1,[illegible]
	Indanthrene blue RS for paper paste	B		
	Indanthrene blue RS for paper trip. powder	B		
	Indanthrene blue RS paste	B		
	Indanthrene blue RS double paste	B		
	Indanthrene blue RS paper paste, sand free	B		
	Indanthrene blue RS trip paper	B		
839	Algole blue K powder	By	121	
840	Indanthrene blue 3G powder	B	551	[illegible]
	Indanthrene blue 3G paste	B		
842	Indanthrene blue GCD paste	B	54,478	[illegible]
	Indanthrene blue GCD paste, sand free	B		
	Indanthrene blue GCD powder	B		
	Indanthrene blue GCD double paste	B		
	Indanthrene blue GCD double paste, sand free	B		
844	Algole blue 3G paste	By	2,079	
845	Indanthrene maroon R paste	B	46	
847	Algole green B paste	By	339	[illegible]
	Algole green B powder	By		
	Algole dark green B powder	By		
848	Indanthrene gray B paste	B	1,949	[illegible]
	Indanthrene gray B powder	B		
	Indanthrene gray B double paste	B		
	Indanthrene gray B double paste, sand free	B		
849	Indanthrene yellow G double paste	B	22,812	[illegible]
	Indanthrene yellow G paste	B		
	Indanthrene yellow G paste, sand free	B		
	Indanthrene yellow R paste double	B		
	Indanthrene yellow R paste	B		
	Indanthrene yellow R paste, sand free	B		
	Indanthrene yellow R double paste, sand free	B		
	Indanthrene yellow powder	B		
850	Indanthrene blue WB powder	B	1,499	
851	Alizarin direct blue B		213	[illegible]
	Alizarin cyanole B	C		
	Alizarin direct blue B	M		
	Alizarin direct blue EB	M		

TABLE 14.—*Imports of dyes for fiscal year 1920*—Continued.

UNIDENTIFIED MORDANT AND CHROME COLORS—Continued.

ultz o.	Name of dye.	Manufacturer.	Imports.	
			Quantity.	Invoice value.
			Pounds.	
	Alizarine delphinol blue SE	Q	300	
	Alizarine emeraldole G powder	By	231	
	Alizarine saphirole WSA powder	By	994	
	Alizarine sky blue 3R powder	By	24	
	Alizarine uranole 2B powder	By	64	
	Anthracene acid brown R	C	115	
	Anthracene blue LG	BD	2,177	
	Anthracene blue SWB powder	B	86	
	Anthracene brown RD paste	G	5,903	
	Anthracene brown WLP paste	BD	634	
	Anthracene chrome blue	G	62	
	Anthracene yellow	G	20	
	Anthracyanine 3FL	By	145	
	Anthracyanine FL conc. 60/100	By	95	
	Anthracyl blue BT	WD	165	
	Anthracyl chrome blue D conc. 125 per cent	WD	8,950	
	Anthracyl chrome brown G	WD	556	
	Anthranol black T double conc	WD	1,389	
	Anthranol blue RD	WD	926	
	Anthranol Bordeaux	WD	6,557	
	Anthranol brown M	WD	311	
	Anthranol green D	WD	242	
	Anthranol orange	WD	351	
	Anthranol yellow	WD	185	
	Brilliant alizarine cyanine 3G paste	By	500	
	Brilliant chrome blue P	S	220	
	Brilliant delphine blue BS	S	90,838	
	Brilliant milling blue B	C	66	
	Cheshire chrome black R	Q	100	
	Cheshire chrome violet R	Q	100	
	Chromazurine G. powder	DH	661	
	Chrome black	WD	6,243	$2,751
	Chrome black G	LG		
	Chrome black PON	CG		
	Chrome brilliant blue G	G	1,102	
	Chrome brown DO	WD	8,434	3,141
	Chrome brown RVV	G		
	Chrome fast brown GR	WD		
	Chrome fast cyanine G	I	1,102	
	Chrome green Y paste	Lev	15,[illegible]95	4,954
	Chrome green Y	Lev		
	Chrome green Y paste	BD		
	Chrome yellow BN	CG	4,562	
	Chromopheazine FKN powder	DH	771	
	Chromorhodine B extra	DH	110	
	Diadem chrome red BR	Q	25	
	Diamond Bordeaux R	LG	597	
	Diamond magenta crystals	WD	666	
	Era black J conc	Lev	120	
	Era chrome dark blue G	Lev	2,240	
	Erio alizarine blue G 150 per cent powder	G	1,[illegible]94	
	Erio chrome azurol BX	G	441	
	Erio chrome red PEI	G	441	
	Erio chrome violet B	G	10,715	
	Erio floxine 6B conc	G	4,431	7,749
	Erio floxine 2G conc			
	Fast violet 222 per cent	WD	220	
	Gallo violet D	By	51	
	Indalizarine I paste	DH	624	372
	Indalizarine I paste	Q		
	New Gallophenine R	By	222	
	Omega chrome brown PB	S	24,098	23,761
	Omega chrome brown P	S		
	Omega chrome brown CPM	S		
	Omega chrome brown G	S		
	Omega chrome green F	S	1,[illegible]74	
	Omega chrome red B	S	991	
	Palatine chrome brown RX	B	4	
	Salicine dark green CS	K	99	

TABLE 14.—*Imports of dyes for fiscal year 1920*—Continued.

Schultz No.	Name of dye.	Manufacturer.	Imports.	
			Quantity.	Invoice value.
			Pounds.	
896	Helindone blue 3GN		427	$1,574
	Helindone blue 3GN	M		
	Helindone blue 3GN concentrated	M		
901	Ciba violet B		40,441	118,796
	Ciba violet B	I		
	Ciba violet B paste 10 per cent	I		
	Ciba violet R paste 10 per cent	I		
	Ciba violet 2B powder	I		
	Ciba violet R	I		
	Ciba violet R	S		
	Ciba violet R powder	I		
	Ciba violet B powder	I		
	Ciba violet B powder 95 per cent	I		
	Ciba violet B paste 10 per cent	SA		
902	Helindone brown 2R		155	290
	Helindone brown 2R paste	M		
	Helindone brown 2R powder	M		
904	Helindone brown G		1,884	7,219
	Helindone brown CR	M		
	Helindone brown CR powder	M		
	Helindone brown G powder	M		
	Helindone brown G paste	M		
906	Thioindigo scarlet G		451	
	Ciba red G powder	I		
907	Ciba scarlet		21,818	24,[illegible]
	Helindone fast scarlet C	M		
	Helindone fast scarlet C paste	M		
	Ciba scarlet G paste	I		
	Ciba scarlet G extra paste and powder	I		
	Ciba scarlet G extra paste	I		
	Ciba scarlet G extra paste 20 per cent	I		
910	Helindone pink		11,122	21,[illegible]
	Helindone pink	M		
	Helindone pink AN 10 per cent	M		
	Helindone pink BN 10 per cent	M		
	Helindone pink BN 10 per cent paste	M		
	Thioindigo rose AN paste	K		
	Thioindigo rose BN paste	K		
912	Thioindigo red B paste	K	276	48
	Thioindigo red B powder	K		
915	Helindone fast scarlet R		179	1,[illegible]
	Helindone fast scarlet R powder	M		
	Helindone fast scarlet R paste	M		
916	Helindone scarlet S		21	
	Helindone scarlet S paste	M		
918	Helindone red 3B		838	1,[illegible]
	Helindone red 3B paste	M		
	Helindone red 3B powder	M		
919	Ciba Bordeaux B paste 10 per cent		1,786	3,[illegible]
	Ciba Bordeaux B paste	I		
	Ciba Bordeaux B powder	I		
920	Helindone violet		6,869	27,[illegible]
	Helindone violet B paste	M		
	Helindone violet BB paste	M		
	Helindone violet B powder	M		
	Helindone violet BB powder	M		
	Helindone violet R	M		
	Helindone violet R paste	M		
	Helindone violet R powder	M		
921	Helindone gray 2 BBR		139	[illegible]
	Helindone gray BB paste	M		
	Helindone gray BB powder	M		
	Helindone gray BR powder	M		
923	Ursol DD		100	
	Ursol 4R paste	A		

UNIDENTIFIED DIRECT DYES.

Alkali black [illegible]	WD	2,205	
Alkali chrome black B	WD	1,014	
Alkali chrome black [illegible]	WD		
Alkali dark green	WD	661	
Alkali orange [illegible]	WD	1,102	

BLE 16.—*Imports of natural dyes and extracts of, entered for consumption, 1917 to June 30, 1920*—Continued.

Calendar year.	Logwood.		Logwood (and other wood extracts).		Madder, ground.	
	Quantity.	Value.	Quantity.	Value.	Quantity.	Value.
	Tons.		*Pounds.*		*Pounds.*	
7	61,714	$1,509,878	736,038	$86,672	2,193	$253
8	33,168	776,735	277,748	45,895	.....	.....
9	29,022	549,885	539,252	62,601	7,875	1,545
30 (6 months)	30,585	874,439	453,932	28,706	1,609	338

Calendar year.	Orchil.		Persian berries, extract.		Safflower, saffron.	
	Pounds.		*Pounds.*		*Pounds.*	
17	.....	$50,005	.....	.....	.....	$105,516
18	.....	56,284	.....	.....	.....	70,032
19	372,606	42,085	5,209	$2,691	[illegible],663	106,951
20 (6 months)	345,801	30,207	11,357	3,631	6,692	80,990

Calendar year.	Turmeric.		Gambier.		All other extracts of vegetable origin.	
	Pounds.		*Pounds.*		*Pounds.*	
917	.....	$1,331	12,050,848	$1,138,833	150,078	$20,757
918	.....	11,278	8,755,270	949,971	2,889,865	234,375
919	1,230,229	68,852	4,744,651	432,499	443,749	80,079
920 (6 months)	758,782	59,071	5,949,423	476,418	253,595	43,397

NOTE.—No imports of camwood and madder extract.

TABLE 17.—*Imports of coal-tar products entered for consumption, Jan. 1, 1917–June 30, 1920.*

Calendar year.	Quantity.	Value.	Duty collected.	Actual and ad valorem rates.
	Pounds.			*Per cent.*
Acetanilid [1] (25 per cent) [2]	.....	.....	.....	.....
Acetphenetidin (25 per cent): [2]				
1917	3,280	$40,352	$10,088	25.00
1918	.....	.....	.....	.....
1919	.....	.....	.....	.....
1920 (6 months)	.....	.....	.....	.....
Acetylsalicylic acid (25 per cent): [2]				
1917	1,474	4,670	1,168	25.00
1918	.....	.....	.....	.....
1919	26	76	19	25.00
1920 (6 months)	.....	.....	.....	.....
Antipyrene (25 per cent): [2]				
1917	21,842	62,411	15,603	25.00
1918	9,416	106,643	26,661	25.00
1919	13,736	135,565	33,891	25.00
1920 (6 months)	10,653	37,576	9,394	25.00
Aspirin [3] (25 per cent) [2]	.....	.....	.....	.....
Salol [1] (25 per cent) [2]	.....	.....	.....	.....
Phenolphthalein (25 per cent): [2]				
1917	.....	.....	.....	.....
1918	100	1,200	300	25.00
1919	.....	.....	.....	.....
1920 (6 months)	200	726	181	25.00
Saccharin (65 cents per pound): [2]				
1917	554	6,544	360	.55
1918	.....	.....	.....	.....
1919	.....	.....	.....	.....
1920 (6 months)	.....	.....	.....	.....

[1] No imports.
[2] Dutiable under the act of Oct. 3, 1913, rather than under the act of Sept. 8, 1916.
[3] Included under acetylsalicylic acid.

TABLE 17a.—*Imports of coal-tar products entered for consumption, Jan. 1, 1917, to June 30, 1920 (act of Sept. 8, 1916).*

GROUP I (FREE).

	Calendar years.						1920 (Jan. 1 to June 30).	
	1917		1918		1919			
	Quantity.	Value.	Quantity.	Value.	Quantity.	Value.	Quantity.	Value.
Acids, carbolic, which on being subjected to distillation yield in the portion distilling below 200° C. a quantity of tar acids less than 5 per cent of original distillate....pounds..	151,254	$9,894	155,236	$17,260	1,965,289	$187,788	69,159	$6,318
Anthracene oil....gallons..	61,200	3,105	.....	.....	18,699	3,994	5,180	1,550
Benzol.....pounds..	3,598,733	341,700	2,673,855	87,570	217,865	5,617	146,819	1,838
Cresol.....do....	7,665,442	532,529	8,873,271	779,045	6,435,650	557,214	5,658,649	440,745
Dead or creosote oil, gallons.....	9,817,085	786,638	1,545,247	162,869	11,288,379	1,374,217	5,239,223	799,336
Naphthalene having a solidifying point less than 79° C.....pounds..	5,208,980	175,554	3,902,731	130,098	3,239,256	92,265	4,713,067	124,706
Pyridine and quinoline, pounds.....	12,247	1,480	9,237	1,036	165,064	20,543	445,411	50,314
Coal tar, crude.....barrels..	6,780	10,745	13,087	21,200	22,339	38,476	11,439	22,[illegible]
Pitch coal tar.....do....	5,926	12,039	14,029	29,095	3,364	8,598	2,909	7,104
Metacresol, orthocresol, and paracresol—purity less than 90 per cent, pounds.....	20,708	1,404	.....	.....	11,200	1,221	.....	.....
Toluol.....pounds..	.....	.....	.....	.....	1,195,706	30,768	.....	.....
Xylol.....do....	9,332	2,928	.....	.....	.....	.....	.....	.....
All other products found naturally in coal tar whether produced or obtained from coal tar or other sources, n. s. p. f., pounds.....	.....	10,448	.....	2,756	380,525	6,334	30,300	1,369
All other distillates, which on being subjected to distillation yield in the portion distilling below 200° C. a quantity of tar acids less than 5 per cent of the original distillate, pounds.....	.....	1,502	.....	10,473	104,568	10,548	.....	.....

GROUP I, CRUDE (FREE).

Anthracene, purity less than 25 per cent.....	*Pounds.* (1)	(1)	*Pounds.* 18	$3	*Pounds.* 82,669	$2,022	*Pounds.* 7,451	$499
Acenaphthene, cumol fluorene, methylanthracene and methylnaphthalene..	(1)	(1)	.....	.....	15,759	946	.....	.....
Carbazol, purity less than 25 per cent.....	(1)	(1)	.....	.....	11[illegible]	[illegible]2	.....	.....

[1] Imports not available by calendar year.

CENSUS OF DYES AND COAL-TAR CHEMICALS

TABLE 17b.—*Imports of coal-tar products entered for consumption, fiscal years ... to June 30, 1920.*

(Act of Sept. 8, 1916.)

GROUP II (DUTIABLE AT 15 PER CENT PLUS 5 PER CENT FEE [illegible])

	[illegible]	[illegible]	[illegible]	[illegible]
Not colors, dyes or stains, photographic chemicals, medicinals, flavors, or explosives, and n. s. p. f.:				
Jan. 1, 1917–Dec. 31, 1917	[illegible]	[illegible]	[illegible]	[illegible]
Jan. 1, 1918–Dec. 31, 1918	[illegible]	[illegible]	[illegible]	[illegible]
Jan. 1, 1919–Dec. 31, 1919	[illegible]	[illegible]	[illegible]	[illegible]
Jan. 1, 1920–June 30, 1920	[illegible]	[illegible]	[illegible]	[illegible]
Carbolic acid (phenol) which on being subjected to distillation yields in the portion distilling below 300° C. a quantity of tar acids equal to or more than 5 per cent of the original distillate:				
Crystal—				
Jan. 1, 1917–Dec. 31, 1917	[illegible]	[illegible]	[illegible]	[illegible]
Jan. 1, 1918–Dec. 31, 1918	[illegible]	[illegible]	[illegible]	[illegible]
Jan. 1, 1919–Dec. 31, 1919	[illegible]	[illegible]	[illegible]	[illegible]
Jan. 1, 1920–June 30, 1920	[illegible]	[illegible]	[illegible]	[illegible]
Liquid—				
Jan. 1, 1917–Dec. 31, 1917	[illegible]	[illegible]	[illegible]	[illegible]
Jan. 1, 1918–Dec. 31, 1918	[illegible]	[illegible]	[illegible]	[illegible]
Jan. 1, 1919–Dec. 31, 1919	[illegible]	[illegible]	[illegible]	[illegible]
Jan. 1, 1920–June 30, 1920	[illegible]	[illegible]	[illegible]	[illegible]
Salicylic acid:				
Jan. 1, 1917–Dec. 31, 1917	[illegible]	[illegible]	[illegible]	[illegible]
Jan. 1, 1918–Dec. 31, 1918	[illegible]	[illegible]	[illegible]	[illegible]
Jan. 1, 1919–Dec. 31, 1919	[illegible]	[illegible]	[illegible]	[illegible]
Jan. 1, 1920–June 30, 1920	[illegible]	[illegible]	[illegible]	[illegible]
Anthraquinone:				
Jan. 1, 1917–Dec. 31, 1917	[illegible]	[illegible]	[illegible]	[illegible]
Jan. 1, 1918–Dec. 31, 1918	[illegible]	[illegible]	[illegible]	[illegible]
Jan. 1, 1919–Dec. 31, 1919	[illegible]	[illegible]	[illegible]	[illegible]
Jan. 1, 1920–June 30, 1920	[illegible]	[illegible]	[illegible]	[illegible]
Methylanthraquinone:				
Jan. 1, 1917–Dec. 31, 1917	[illegible]	[illegible]	[illegible]	[illegible]
Jan. 1, 1918–Dec. 31, 1918	[illegible]	[illegible]	[illegible]	[illegible]
Jan. 1, 1919–Dec. 31, 1919	[illegible]	[illegible]	[illegible]	[illegible]
Jan. 1, 1920–June 30, 1920	[illegible]	[illegible]	[illegible]	[illegible]
Dinitrotoluol:				
Jan. 1, 1917–Dec. 31, 1917	[illegible]	[illegible]	[illegible]	[illegible]
Jan. 1, 1918–Dec. 31, 1918	[illegible]	[illegible]	[illegible]	[illegible]
Jan. 1, 1919–Dec. 31, 1919	[illegible]	[illegible]	[illegible]	[illegible]
Jan. 1, 1920–Jan. 20, 1920	[illegible]	[illegible]	[illegible]	[illegible]
Naphthalene solidifying at 79° C. or above:				
Jan. 1, 1917–Dec. 31, 1917	[illegible]	[illegible]	[illegible]	[illegible]
Jan. 1, 1918–Dec. 31, 1918	[illegible]	[illegible]	[illegible]	[illegible]
Jan. 1, 1919–Dec. 31, 1919	[illegible]	[illegible]	[illegible]	[illegible]
Jan. 1, 1920–June 30, 1920	[illegible]	[illegible]	[illegible]	[illegible]
Naphthol:				
Jan. 1, 1917–Dec. 31, 1917	[illegible]	[illegible]	[illegible]	[illegible]
Jan. 1, 1918–Dec. 31, 1918	[illegible]	[illegible]	[illegible]	[illegible]
Jan. 1, 1919–Dec. 31, 1919	[illegible]	[illegible]	[illegible]	[illegible]
Jan. 1, 1920–June 30, 1920	[illegible]	[illegible]	[illegible]	[illegible]
Nitronaphthalene:				
Jan. 1, 1917–Dec. 31, 1917	[illegible]	[illegible]	[illegible]	[illegible]
Jan. 1, 1918–Dec. 31, 1918	[illegible]	[illegible]	[illegible]	[illegible]
Jan. 1, 1919–Dec. 31, 1919	[illegible]	[illegible]	[illegible]	[illegible]
Jan. 1, 1920–June 30, 1920	[illegible]	[illegible]	[illegible]	[illegible]
Nitrotoluol:				
Jan. 1, 1917–Dec. 31, 1917	[illegible]	[illegible]	[illegible]	[illegible]
Jan. 1, 1918–Dec. 31, 1918	[illegible]	[illegible]	[illegible]	[illegible]
Jan. 1, 1919–Dec. 31, 1919	[illegible]	[illegible]	[illegible]	[illegible]
Jan. 1, 1920–June 30, 1920	[illegible]	[illegible]	[illegible]	[illegible]
Phthalic anhydride:				
Jan. 1, 1917–Dec. 31, 1917	[illegible]	[illegible]	[illegible]	[illegible]
Jan. 1, 1918–Dec. 31, 1918	[illegible]	[illegible]	[illegible]	[illegible]
Jan. 1, 1919–Dec. 31, 1919	[illegible]	[illegible]	[illegible]	[illegible]
Jan. 1, 1920–June 30, 1920	[illegible]	[illegible]	[illegible]	[illegible]
Naphthylamine:				
Jan. 1, 1917–Dec. 31, 1917	[illegible]	[illegible]	[illegible]	[illegible]
Jan. 1, 1918–Dec. 31, 1918	[illegible]	[illegible]	[illegible]	[illegible]
Jan. 1, 1919–Dec. 31, 1919	[illegible]	[illegible]	[illegible]	[illegible]
Jan. 1, 1920–June 30, 1920	[illegible]	[illegible]	[illegible]	[illegible]

TABLE 17b.—*Imports of coal-tar products entered for consumption, Jan. 1, 191[illegible] to June 30, 1920*—Continued.

GROUP II (DUTIABLE AT 15 PER CENT PLUS 2½ CENTS PER POUND)—Continued

	Quantity.	Value.	Duty.	Actual and computed ad valorem rate.
Amidonaphthol:	*Pounds.*			*Per cent.*
Jan. 1, 1917–Dec. 31, 1917				
Jan. 1, 1918–Dec. 31, 1918				
Jan. 1, 1919–Dec. 31, 1919	150	$72	$14.55	20.2
Jan. 1, 1920–June 30, 1920				
Amidophenol:				
Jan. 1, 1917–Dec. 31, 1917				
Jan. 1, 1918–Dec. 31, 1918				
Jan. 1, 1919–Dec. 31, 1919	1,028	2,417	388.25	[illegible]
Jan. 1, 1920–June 30, 1920				
Anthracene, purity of 25 per cent or more:				
Jan. 1, 1917–Dec 31, 1917				
Jan. 1, 1918–Dec. 31, 1918				
Jan. 1, 1919–Dec. 31, 1919	51,895	8,011	2,499.02	31.1
Jan. 1, 1920–June 30, 1920				
Benzaldehyde:				
Jan. 1, 1917–Dec. 31, 1917				
Jan. 1, 1918–Dec. 31, 1918				
Jan. 1, 1919–Dec. 31, 1919	24,472	17,790	3,280.30	18.4
Jan. 1, 1920–June 30, 1920	9,479	5,928	1,126.00	19.0
Dimethylaniline:				
Jan. 1, 1917–Dec. 31, 1917				
Jan. 1, 1918–Dec. 31, 1918				
Jan. 1, 1919–Dec. 31, 1919	1,120	427	92.05	21.5
Jan. 1, 1920–June 30, 1920				
Nitrobenzol:				
Jan. 1, 1917–Dec. 31, 1917				
Jan. 1, 1918–Dec. 31, 1918				
Jan. 1, 1919–Dec. 31, 1919	21,513	4,003	1,138.28	28.4
Jan. 1, 1920–June 30, 1920	22,110	3,219	1,036.00	32.1
Phenylenediamine:				
Jan. 1, 1917–Dec. 31, 1917				
Jan. 1, 1918–Dec. 31, 1918				
Jan. 1, 1919–Dec. 31, 1919	2,746	1,769	334.00	18.8
Jan. 1, 1920–June 30, 1920	•2,429	1,887	345.00	18.2
Resorcin:				
Jan. 1, 1917–Dec. 31, 1917	134	672	104.00	15.5
Jan. 1, 1918–Dec. 31, 1918				
Jan. 1, 1919–Dec. 31, 1919				
Jan. 1, 1920–June 30, 1920	5,159	2,642	525.00	19.8
Anilin salt:				
Jan. 1, 1917–Dec. 31, 1917				
Jan. 1, 1918–Dec. 31, 1918	21,273	3,250	1,019.00	31.3
Jan. 1, 1919–Dec. 31, 1919				
Jan. 1, 1920–June 30, 1920				
Benzylchloride:				
Jan. 1, 1917–Dec. 31, 1917	5	7	1.00	16.6
Jan. 1, 1918–Dec. 31, 1918				
Jan. 1, 1919–Dec. 31, 1919	1,000	430	89.50	20.8
Jan. 1, 1920–June 30, 1920	150	22	7.05	
Alldistillates, n. s. p. f., which on distillation yield in the portion distilling below 200° C. a quantity of tar acids equal to or more than 5 per cent of the original distillate:				
Jan. 1, 1917–Dec. 31, 1917				
Jan. 1, 1918–Dec. 31, 1918	1,550	2,008	339.95	16.9
Jan. 1, 1919–Dec. 31, 1919	3,170	4,587	767.30	16.7
Jan. 1, 1920–June 30, 1920	22,399	18,423	3,323.00	18.0
Allsimilar products obtained, derived, or manufactured in whole or in part from the products provided for in Group I (free):				
Jan. 1, 1917–Dec. 31, 1917	193,021	17,595	7,465.00	42.4
Jan. 1, 1918–Dec. 31, 1918	13,445	8,640	1,632.12	18.8
Jan. 1, 1919–Dec. 31, 1919	51,214	39,861	7,259.50	18.2
Jan. 1, 1920–June 30, 1920	38,575	35,463	6,284.00	17.7

TABLE 17b.—*Imports of coal-tar products entered for consumption, Jan. 1, 1917, to June 30, 1920*—Continued.

GROUP III (DUTIABLE AT 30 PER CENT AD VALOREM

	Quantity.	Value.	Duty.	Duty per pound.
When obtained, derived, or manufactured in whole or in part from any of the products provided for in Group I (free) or II, including natural indigo and their derivatives:				
Alizarin, natural—	Pounds.			
Jan. 1, 1917–Dec. 31, 1917	6,[illegible]	$[illegible]	$[illegible]	[illegible]
Jan. 1, 1918–Dec. 31, 1918	176,711	[illegible]	[illegible]	[illegible]
Jan. 1, 1919–Dec. 31, 1919	6,[illegible]	[illegible]	[illegible]	[illegible]
Jan. 1, 1920–June 30, 1920				
Alizarin, synthetic—				
Jan. 1, 1917–Dec. 31, 1917	19,[illegible]	[illegible]	[illegible]	[illegible]
Jan. 1, 1918–Dec. 31, 1918				
Jan. 1, 1919–Dec. 31, 1919				
Jan. 1, 1920–June 30, 1920	[illegible]	[illegible]	[illegible]	[illegible]
Dyes obtained, derived, or manufactured from alizarin—				
Jan. 1, 1917–Dec. 31, 1917	[illegible]	[illegible]	[illegible]	[illegible]
Jan. 1, 1918–Dec. 31, 1918	[illegible]	[illegible]	[illegible]	[illegible]
Jan. 1, 1919–Dec. 31, 1919	[illegible]	[illegible]	[illegible]	[illegible]
Jan. 1, 1920–June 30, 1920	[illegible]	[illegible]	[illegible]	[illegible]
Dyes obtained, derived, or manufactured from anthracene and carbazol—				
Jan. 1, 1917–Dec. 31, 1917	[illegible]	[illegible]	[illegible]	[illegible]
Jan. 1, 1918–Dec. 31, 1918	[illegible]	[illegible]	[illegible]	[illegible]
Jan. 1, 1919–Dec. 31, 1919	[illegible]	[illegible]	[illegible]	[illegible]
Jan. 1, 1920–June 30, 1920	[illegible]	[illegible]	[illegible]	[illegible]
Indigoids, whether or not obtained from indigo—				
Jan. 1, 1917–Dec. 31, 1917	[illegible]	[illegible]	[illegible]	[illegible]
Jan. 1, 1918–Dec. 31, 1918	[illegible]	[illegible]	[illegible]	[illegible]
Jan. 1, 1919–Dec. 31, 1919	[illegible]	[illegible]	[illegible]	[illegible]
Jan. 1, 1920–June 30, 1920	[illegible]	[illegible]	[illegible]	[illegible]
Flavors—				
Jan. 1, 1917–Dec. 31, 1917	[illegible]	[illegible]	[illegible]	[illegible]
Jan. 1, 1918–Dec. 31, 1918	[illegible]	[illegible]	[illegible]	[illegible]
Jan. 1, 1919–Dec. 31, 1919				
Jan. 1, 1920–June 30, 1920				
Indigo, natural—				
Jan. 1, 1917–Dec. 31, 1917	[illegible]	[illegible]	[illegible]	[illegible]
Jan. 1, 1918–Dec. 31, 1918	[illegible]	[illegible]	[illegible]	[illegible]
Jan. 1, 1919–Dec. 31, 1919	[illegible]	[illegible]	[illegible]	[illegible]
Jan. 1, 1920–June 30, 1920	[illegible]	[illegible]	[illegible]	[illegible]
Indigo, synthetic—				
Jan. 1, 1917–Dec. 31, 1917	[illegible]	[illegible]	[illegible]	[illegible]
Jan. 1, 1918–Dec. 31, 1918	[illegible]	[illegible]	[illegible]	[illegible]
Jan. 1, 1919–Dec. 31, 1919	[illegible]	[illegible]	[illegible]	[illegible]
Jan. 1, 1920–June 30, 1920	[illegible]	[illegible]	[illegible]	[illegible]
Medicinals—				
Jan. 1, 1917–Dec. 31, 1917	[illegible]	[illegible]	[illegible]	[illegible]
Jan. 1, 1918–Dec. 31, 1918	[illegible]	[illegible]	[illegible]	[illegible]
Jan. 1, 1919–Dec. 31, 1919	[illegible]	[illegible]	[illegible]	[illegible]
Jan. 1, 1920–June 30, 1920	[illegible]	[illegible]	[illegible]	[illegible]

GROUP III (DUTIABLE AT 30 PER CENT AD VALOREM PLUS CENTS PER POUND)

	Quantity.	Value.	Duty.	Duty per pound.
When obtained, derived, or manufactured in whole or in part from any of the products provided for in Group I (free) or II, including natural indigo and their derivatives:				
Colors, or color lakes obtained, derived, or manufactured from alizarin—	Pounds.	Dollars.	Dollars.	Per cent.
Jan. 1, 1917–Dec. 31, 1917	7,[illegible]	[illegible]	[illegible]	[illegible]
Jan. 1, 1918–Dec. 31, 1918	1,[illegible]	[illegible]	[illegible]	[illegible]
Jan. 1, 1919–Dec. 31, 1919	15,[illegible]	[illegible]	[illegible]	[illegible]
Jan. 1, 1920–June 30, 1920	9,[illegible]	[illegible]	[illegible]	[illegible]
Colors, or color lakes obtained, derived, or manufactured from anthracene and carbazol—				
Jan. 1, 1917–Dec. 31, 1917	[illegible]	[illegible]	[illegible]	[illegible]
Jan. 1, 1918–Dec. 31, 1918	[illegible]	[illegible]	[illegible]	[illegible]
Jan. 1, 1919–Dec. 31, 1919	[illegible]	[illegible]	[illegible]	[illegible]
Jan. 1, 1920–June 30, 1920	[illegible]	[illegible]	[illegible]	[illegible]

TABLE 14.—*Imports of dyes for fiscal year 1920*—Continued.

UNIDENTIFIED SULPHUR COLORS—Continued.

Schultz No.	Name of dye.	Manufacturer.	Imports.	
			Quantity.	Invoice value
			Pounds.	
	Sulphur yellow G	S	2,424	
	Sulphurol dark brown	WD	992	31
	Sulphurol dark brown G	WD		
	Sulphurol indigo blue, conc	WD	1,157	23
	Sulphurol indigo B. conc	WD		
	Sulphurol indigo R. conc	WD		
	Sulphurol orange	WD	441	
	Thiamine green, 2G	Q	4,950	
	Thiamine brilliant green 2Y	Q	2,381	
	Thiazol yellow G conc	S	330	
	Thiogene New blue 2R L	M	900	
	Thional brilliant blue 6B	S	7,670	22
	Thional brilliant blue 6B conc. pure	S		
	Thional brilliant green GG	S	396	
	Thional yellow G	S	8,377	15
	Thional brilliant yellow G	S		
	Thional brilliant yellow GG	S		
	Thional bronze GV	S	220	
	Thional brown GD	BD	27,887	
	Thional brown GD	Lev		
	Thional blue BR	Lev	470	
	Thional orange G	S	1,638	
	Thional yellow 3RD	S	6,407	
	Thional brilliant green 4GX	BD	9,186	
	Thional brilliant green 4GX	Lev		
	Thional brown R	BD	15,432	
	Thional brown R	Lev		
	Thional corinth RBX	BD	10,970	
	Thional direct blue S	BD	2,240	
	Thional green 3B	BD	7,840	6,27
	Thional green 3B	Lev		
	Thional green DY	Lev	30,332	
	Thional green DY	BD		
	Thionine green 2G	Q	11,647	
	Thional yellow GR	Lev	4,980	
	Thional yellow GR	BD		
	Thional yellow 3RD	BD	27,618	
	Thional yellow 3RD	Lev		

UNIDENTIFIED MORDANT AND CHROME COLORS.

	Acid alizarine black EN	M	6,596	$3,27
	Acid alizarine black ENT	M		
	Acid alizarine black ENT, conc	M		
	Acid alizarine black SE, paste	M		
	Acid alizarine black SET	M		
	Acid alizarine SET paste	M		
	Acid alizarine blue A	M	40	
	Acid alizarine blue black A	M	59	
	Acid alizarine gray G	M	441	
	Acid alizarine red B	M	201	
	Acid chrome violet B	By	227	
	Acid milling red G conc	G	2,424	
	Acid milling red G conc	S		
	Alizarine acid blue	Q	25	
	Alizarine blue OCR conc	S	1,332	2,70
	Alizarine blue OCR conc. double	S		
	Alizarine chrome green A	S	900	
	Alizarine claret 100	M	15	
	Alizarine claret R paste 15 per cent	M	26	
	Alizarine cyanine WRB paste	By	2,401	
	Alizarine cyanine WRR paste	By	9,755	
	Alizarine cyanine green G extra powder	By	500	
	Alizarine cyanine NS powder	By	330	
	Alizarine cyanine WRB powder	By	330	
	Alizarine cyanole EF	C	7	
	Alizarine cyanole SR	C	9	
	Alizarine delphinol SE	BD	112	

TABLE 14.—*Imports of dyes for fiscal year 1920*—Continued.

UNIDENTIFIED MORDANT AND CHROME COLORS—Continued.

Schultz No.	Name of dye.	Manufacturer.	Imports.	
			Quantity.	Invoice value.
			Pounds.	
	Alizarine delphinol blue SE	Q	300	
	Alizarine emeraldole G powder	By	231	
	Alizarine saphirole WSA powder	By	994	
	Alizarine sky blue 3R powder	By	24	
	Alizarine uranole 2B powder	By	64	
	Anthracene acid brown R	C	115	
	Anthracene blue LG	BD	2,177	
	Anthracene blue SWB powder	B	86	
	Anthracene brown RD paste	G	5,908	
	Anthracene brown WLP paste	BD	634	
	Anthracene chrome blue	G	62	
	Anthracene yellow	G	20	
	Anthracyanine 3FL	By	145	
	Anthracyanine FL conc. 60/100	By	95	
	Anthracyl blue BT	WD	165	
	Anthracyl chrome blue D conc. 125 per cent	WD	8,950	
	Anthracyl chrome brown G	WD	556	
	Anthranol black T double conc	WD	1,389	
	Anthranol blue RD	WD	928	
	Anthranol Bordeaux	WD	6,577	
	Anthranol brown M	WD	311	
	Anthranol green D	WD	242	
	Anthranol orange	WD	381	
	Anthranol yellow	WD	185	
	Brilliant alizarine cyanine 3G paste	By	500	
	Brilliant chrome blue P	S	220	
	Brilliant delphine blue BS	S	90,838	
	Brilliant milling blue B	C	66	
	Cheshire chrome black R	Q	100	
	Cheshire chrome violet R	Q	100	
	Chromazurine G. powder	DH	661	
	Chrome black	WD	6,243	$2,751
	Chrome black G	LG		
	Chrome black PON	CG		
	Chrome brilliant blue G	G	1,102	
	Chrome brown DO	WD	8,434	3,141
	Chrome brown RVV	G		
	Chrome fast brown GR	WD		
	Chrome fast cyanine G	I	1,102	
	Chrome green Y paste	Lev	15,906	4,954
	Chrome green Y	Lev		
	Chrome green Y paste	BD		
	Chrome yellow BN	CG	4,562	
	Chromophenine FKN powder	DH	771	
	Chromorhodine B extra	DH	110	
	Diadem chrome red BR	Q	25	
	Diamond Bordeaux R	LG	997	
	Diamond magenta crystals	WD	666	
	Era black J conc	Lev	120	
	Era chrome dark blue G	Lev	2,240	
	Erio alizarine blue G 150 per cent powder	G	1,994	
	Erio chrome azurol BX	G	441	
	Erio chrome red PEI	G	441	
	Erio chrome violet B	G	10,715	
	Erio floxine 6B conc	G	4,431	7,749
	Erio floxine 2G conc			
	Fast violet 222 per cent	WD	220	
	Gallo violet D	By	61	
	Indalizarine I paste	DH	621	372
	Indalizarine I paste	Q		
	New Gallophenine R	By	222	
	Omega chrome brown PB	S	24,086	24,701
	Omega chrome brown P	S		
	Omega chrome brown CPM	S		
	Omega chrome brown G	S		
	Omega chrome green F	S	1,874	
	Omega chrome red B	S	991	
	Palatine chrome brown BX	B	4	
	Salicine dark green G	K	70	

TABLE 14.—*Imports of dyes for fiscal year 1920*—Continued.

UNIDENTIFIED BASIC COLORS.

Schultz No.	Name of dye.	Manufacturer.	Imports.	
			Quantity.	Invoice value
			Pounds.	
	Corn blue B conc. 143 per cent	WD	644	$[illegible]
	Corn blue R	WD		
	Indocyanine B	LG	441	
	Pyrophosphine GG	WD	441	
	Rosazcine 6G extra	M	220	
	Rosolane B conc	M	80	
	Seto Blue VE	G	1,651	
	Tannin yellow GE	Q	125	
	Turquoise blue BB	By	201	
	Rhoduline heliotrope B	By	11	
	Rhoduline heliotrope 3B	By	24	
	Victoria blue 4BS	S	772	

UNIDENTIFIED OIL-SOLUBLE DYES.

	Oil-soluble dyes		1,334	$[illegible]
	Olisol blue	WD		
	Olisol carmoisine	WD		
	Olisol yellow	WD		
	Spirit aurine	Q		
	Sudan 6	WD		

UNIDENTIFIED DYES FOR COLOR LAKES.

	Brilliant lake blue G extra	By	496	
	Helio Bordeaux BL powder	By	500	
	Helio fast blue BL conc	By	339	
	Lithol fast orange R paste	B	110	
	Lithol Rubine G powder	B	249	
	Pigment scarlet 3B	M	1,000	

UNIDENTIFIED UNCLASSIFIED COLORS.

	Bistre T	Q	1,653	
	Du Olive GL powder	Lev	2,240	
	Ink Blue BJIBN	GrE	29	
	Mounsey Olive brown	Q	100	
	New fast red GGL conc	BK	1,598	
	Nitro orange OT 115 per cent	BK	662	$[illegible]
	Nitro orange RR conc. 110 per cent	BK		
	Paper black	M	1,146	
	Paper red O	WD	13,701	5,[illegible]
	Paper Red O conc	WD		
	Paper red 690	WD		
	Paper red R	WD		
	Parasulphone brown V	S	611	
	Parasulphone bronze GS	S	110	
	Peacock blue	Q	1,182	
	Red bluish CPBN	Q	1,102	
	Scarlet Z	BK	1,186	
	Tartraphenine	Q	720	
	Thianine Brilliant green 2Y	Q	1,120	
	Tibet black FWN	WD	882	
	All other		9,352	14,[illegible]
	Total		3,501,147	4,54[illegible]

Part IV.—APPENDIX

STATISTICS OF IMPORTS AND EXPORTS

DIRECTORY OF MANUFACTURERS OF COAL-TAR PRODUCTS

TABLE 15.—*Imports of dyes entered for consumption for 1917, 1918, 1919, and first 6 months of 1920 (calendar years).*

	1917		1918		1919		1920 (6 months)	
	Quantity.	Value.	Quantity.	Value.	Quantity.	Value.	Quantity.	Value.
Alizarin:								
Natural, 30 per cent	*Pounds.* 6,899	$12,216	*Pounds.* 108,711	$158,816	*Pounds.* 6,634	$8,612	*Pounds.*	
Synthetic, 30 per cent	19,180	55,179					58,810	
Colors or color lakes obtained, derived, or manufactured from alizarin, 30 per cent plus 5 cents per pound	7,062	18,680	1,499	4,490	15,358	14,405	9,061	
Dyes obtained, derived, or manufactured from alizarin, 30 per cent	34	75	6,446	13,399	1,920	3,864	17,777	
Colors or color lakes obtained, derived, or manufactured from anthracene and carbazol, 30 per cent plus 5 cents per pound	53,205	49,729	27,900	22,546	38,073	55,475	40,991	
Dyes obtained, derived, or manufactured from anthracene and carbazol, 30 per cent	23,146	11,326	12,827	20,037	7,162	7,772	29,275	
Indigo:								
Natural	2,261,122	4,230,510	1,637,914	2,007,958	234,991	285,925	20,574	
Synthetic	1,379,349	871,267	690,414	342,589	537,697	327,133	99,419	
Indigoids, whether or not obtained from indigo	129,983	140,932	3,376	13,744	34,049	82,779	38,379	
All other colors, dyes, or stains, whether soluble or not, etc., 30 per cent plus 5 cents per pound	2,257,476	2,574,363	1,799,467	2,161,799	1,991,687	2,843,294	1,368,604	

TABLE 16.—*Imports of natural dyes and extracts of, entered for consumption, 1917 to June 30, 1920.*

Calendar year.	Annatto.		Cochineal.		Cudbear.	
	Quantity.	Value.	Quantity.	Value.	Quantity.	Value.
	Pounds.		*Pounds.*		*Pounds.*	
1917	660,102	$77,238	121,879	$48,345	55,897	
1918	655,250	62,961	237,402	116,660	54,447	
1919	356,432	19,972	116,014	52,029	33,391	
1920 (6 months)	759,117	31,002	106,804	44,215	17,924	

Calendar year.	Dyewoods, diverse.		Fustic wood.		Indigo, natural	
	Tons.		*Tons.*		*Pounds.*	
1917	7,565	$94,029	10,442	$289,756	2,261,122	
1918	15,966	407,190	11,866	280,813	1,637,914	
1919	922	23,286	696	15,091	234,991	
1920 (6 months)	1,539	29,913	829	16,567	20,574	

TABLE 16.—*Imports of natural dyes and extracts of, entered for consumption, 1917 to June 30, 1920*—Continued.

Calendar year.	Logwood.		Logwood (and other wood extracts).		Madder, ground.	
	Quantity.	Value.	Quantity.	Value.	Quantity.	Value.
	Tons.		*Pounds.*		*Pounds.*	
1917	61,714	$1,509,878	736,038	$86,672	2,193	$253
1918	33,168	776,735	277,748	45,895		
1919	29,022	549,885	539,252	62,601	7,875	1,545
1920 (6 months)	30,585	874,439	453,932	28,706	1,609	339

Calendar year.	Orchil.		Persian berries, extract.		Safflower, saffron	
	Pounds.		*Pounds.*		*Pounds.*	
1917		$50,005				$105,516
1918		56,284				70,632
1919	372,606	42,085	5,209	$2,691	[illegible],663	105,951
1920 (6 months)	345,801	30,207	11,357	3,631	6,692	50,990

Calendar year.	Turmeric.		Gambier.		All other extracts of vegetable origin.	
	Pounds.		*Pounds.*		*Pounds.*	
1917		$1,331	12,050,843	$1,138,833	150,078	$20,757
1918		11,278	8,755,270	949,971	2,899,865	234,375
1919	1,230,229	68,852	4,744,651	432,499	443,749	90,079
1920 (6 months)	758,782	59,071	5,949,423	476,418	253,595	43,397

NOTE.—No imports of camwood and madder extract.

TABLE 17.—*Imports of coal-tar products entered for consumption, Jan. 1, 1917–June 30, 1920.*

Calendar year.	Quantity.	Value.	Duty collected.	Actual and ad valorem rates.
	Pounds.			*Per cent.*
Acetanilid[1] (25 per cent)[2]				
Acetphenetidin (25 per cent):[2]				
1917	3,280	$40,352	$10,088	25.00
1918				
1919				
1920 (6 months)				
Acetylsalicylic acid (25 per cent):[2]				
1917	1,474	4,670	1,168	25.00
1918				
1919	26	76	19	25.00
1920 (6 months)				
Antipyrene (25 per cent):[2]				
1917	21,842	62,411	15,603	25.00
1918	9,416	106,643	26,661	25.00
1919	13,736	135,565	33,891	25.00
1920 (6 months)	10,653	37,576	9,394	25.00
Benzoin[3] (25 per cent)[2]				
Phenacetin (25 per cent)[2]				
Phenolphthalein (25 per cent):[2]				
1917				
1918	100	1,200	300	25.00
1919				
1920 (6 months)	200	726	181	25.00
Saccharin (65 cents per pound):[2]				
1917	554	6,544	360	5.50
1918				
1919				
1920 (6 months)				

[1] No imports.
[2] Dutiable under the act of Oct. 3, 1913, rather than under the act of Sept. 8, 1916.
[3] Included under acetylsalicylic acid.

TABLE 17a.—*Imports of coal-tar products entered for consumption, Jan. 1, 1917, to June 30, 1920 (act of Sept. 8, 1916).*

GROUP I (FREE).

	Calendar years.						1920 (Jan. 1 to June 30).	
	1917		1918		1919			
	Quantity.	Value.	Quantity.	Value.	Quantity.	Value.	Quantity.	Value.
Acids, carbolic, which on being subjected to distillation yield in the portion distilling below 200° C. a quantity of tar acids less than 5 per cent of original distillate....pounds..	151,254	$9,894	155,236	$17,260	1,965,289	$187,788	69,159	$6,318
Anthracene oil....gallons..	61,200	3,105	.....	.....	18,699	3,994	5,180	1,350
Benzol.....pounds..	3,598,733	341,700	2,673,855	87,570	217,865	5,617	146,819	1,806
Cresol.....do....	7,665,442	532,529	8,873,271	779,045	6,435,650	557,214	5,658,649	440,745
Dead or creosote oil, gallons.....	9,817,085	786,638	1,545,247	162,869	11,268,379	1,374,217	5,239,223	799,736
Naphthalene having a solidifying point less than 79° C.....pounds..	5,208,980	175,554	3,902,731	130,098	3,239,256	92,265	4,713,067	124,706
Pyridine and quinoline, pounds.....	12,247	1,480	9,237	1,036	165,064	20,543	445,411	50,314
Coal tar, crude.....barrels..	6,780	10,745	13,087	21,200	22,339	38,476	11,439	22,291
Pitch coal tar.....do....	5,926	12,039	14,029	29,095	3,364	8,598	2,909	7,104
Metacresol, orthocresol, and paracresol—purity less than 90 per cent, pounds.....	20,708	1,404	.....	.....	11,200	1,221	.....	.....
Toluol.....pounds..	.....	.....	.....	.....	1,195,706	30,768	.....	.....
Xylol.....do....	9,332	2,928	.....	.....	.....	.....	.....	.....
All other products found naturally in coal tar whether produced or obtained from coal tar or other sources, n. s. p. f., pounds.....	.....	10,448	.....	2,756	380,525	6,334	50,500	1,369
All other distillates, which on being subjected to distillation yield in the portion distilling below 200° C. a quantity of tar acids less than 5 per cent of the original distillate, pounds.....	.....	1,502	.....	10,473	104,568	10,548	.....	.....

GROUP I, CRUDE (FREE).

Anthracene, purity less than 25 per cent.....	*Pounds.* (1)	(1)	*Pounds.* 18	$5	*Pounds.* 82,669	$2,022	*Pounds.* 7,451	$499
Acenaphthene, cumol fluorene, methylanthracene and methylnaphthalene..	(1)	(1)	.....	.....	15,759	946	.....	.....
Carbazol, purity less than 25 per cent.....	(1)	(1)	.....	.....	11:	82	.....	.....

[1] Imports not available by calendar year.

TABLE 17b.—*Imports of coal-tar products entered for consumption from July 1, 1916, to June 30, 1920.*

(Act of Sept. 8, 1916.)

GROUP II (DUTIABLE AT 15 PER CENT ELSEWHERE SPECIFIED)

	Quantity	Value	Duty	Duty as percentage of value
Not colors, dyes or stains, photographic chemicals, medicinals, flavors, or explosives, and not specially provided for:	Pounds			
Jan. 1, 1917–Dec. 31, 1917				
Jan. 1, 1918–Dec. 31, 1918				
Jan. 1, 1919–Dec. 31, 1919				
Jan. 1, 1920–June 30, 1920				
Carbolic acid (phenol which on being subjected to distillation yields in the portion distilling below 210° C. a quantity of tar acids equal to or more than 95 per cent of the original distillate):				
Crystal—				
Jan. 1, 1917–Dec. 31, 1917				
Jan. 1, 1918–Dec. 31, 1918				
Jan. 1, 1919–Dec. 31, 1919				
Jan. 1, 1920–June 30, 1920				
Liquid—				
Jan. 1, 1917–Dec. 31, 1917				
Jan. 1, 1918–Dec. 31, 1918				
Jan. 1, 1919–Dec. 31, 1919				
Jan. 1, 1920–June 30, 1920				
Salicylic acid:				
Jan. 1, 1917–Dec. 31, 1917				
Jan. 1, 1918–Dec. 31, 1918				
Jan. 1, 1919–Dec. 31, 1919				
Jan. 1, 1920–June 30, 1920				
Anthraquinone:				
Jan. 1, 1917–Dec. 31, 1917				
Jan. 1, 1918–Dec. 31, 1918				
Jan. 1, 1919–Dec. 31, 1919				
Jan. 1, 1920–June 30, 1920				
Methylanthraquinone:				
Jan. 1, 1917–Dec. 31, 1917				
Jan. 1, 1918–Dec. 31, 1918				
Jan. 1, 1919–Dec. 31, 1919				
Jan. 1, 1920–June 30, 1920				
Dinitrotoluol:				
Jan. 1, 1917–Dec. 31, 1917				
Jan. 1, 1918–Dec. 31, 1918				
Jan. 1, 1919–Dec. 31, 1919				
Jan. 1, 1920–Jan. 30, 1920				
Naphthalene solidifying at 79° C. or above:				
Jan. 1, 1917–Dec. 31, 1917				
Jan. 1, 1918–Dec. 31, 1918				
Jan. 1, 1919–Dec. 31, 1919				
Jan. 1, 1920–June 30, 1920				
Naphthol:				
Jan. 1, 1917–Dec. 31, 1917				
Jan. 1, 1918–Dec. 31, 1918				
Jan. 1, 1919–Dec. 31, 1919				
Jan. 1, 1920–June 30, 1920				
Nitronaphthalene:				
Jan. 1, 1917–Dec. 31, 1917				
Jan. 1, 1918–Dec. 31, 1918				
Jan. 1, 1919–Dec. 31, 1919				
Jan. 1, 1920–June 30, 1920				
Nitrotoluol:				
Jan. 1, 1917–Dec. 31, 1917				
Jan. 1, 1918–Dec. 31, 1918				
Jan. 1, 1919–Dec. 31, 1919				
Jan. 1, 1920–June 30, 1920				
Phthalic anhydride:				
Jan. 1, 1917–Dec. 31, 1917				
Jan. 1, 1918–Dec. 31, 1918				
Jan. 1, 1919–Dec. 31, 1919				
Jan. 1, 1920–June 30, 1920				
Naphthylamine:				
Jan. 1, 1917–Dec. 31, 1917				
Jan. 1, 1918–Dec. 31, 1918				
Jan. 1, 1919–Dec. 31, 1919				
Jan. 1, 1920–June 30, 1920				

TABLE 17b.—*Imports of coal-tar products entered for consumption, Jan. 1, 191[illegible] to June 30, 1920*—Continued.

GROUP II (DUTIABLE AT 15 PER CENT PLUS 2½ CENTS PER POUND)—Continued.

	Quantity.	Value.	Duty.	Actual and [illegible] put[illegible] valor[illegible] rate.
Amidonaphthol:	*Pounds.*			*Per cent*
Jan. 1, 1917–Dec. 31, 1917				
Jan. 1, 1918–Dec. 31, 1918				
Jan. 1, 1919–Dec. 31, 1919	150	$72	$14.55	20.2
Jan. 1, 1920–June 30, 1920				
Amidophenol:				
Jan. 1, 1917–Dec. 31, 1917				
Jan. 1, 1918–Dec. 31, 1918				
Jan. 1, 1919–Dec. 31, 1919	1,028	2,417	388.25	16.[illegible]
Jan. 1, 1920–June 30, 1920				
Anthracene, purity of 25 per cent or more:				
Jan. 1, 1917–Dec 31, 1917				
Jan. 1, 1918–Dec. 31, 1918				
Jan. 1, 1919–Dec. 31, 1919	51,895	8,011	2,499.02	31.[illegible]
Jan. 1, 1920–June 30, 1920				
Benzaldehyde:				
Jan. 1, 1917–Dec. 31, 1917				
Jan. 1, 1918–Dec. 31, 1918				
Jan. 1, 1919–Dec. 31, 1919	24,472	17,790	3,280.30	18.[illegible]
Jan. 1, 1920–June 30, 1920	9,479	5,928	1,126.00	19.[illegible]
Dimethylaniline:				
Jan. 1, 1917–Dec. 31, 1917				
Jan. 1, 1918–Dec. 31, 1918				
Jan. 1, 1919–Dec. 31, 1919	1,120	427	92.05	21.[illegible]
Jan. 1, 1920–June 30, 1920				
Nitrobenzol:				
Jan. 1, 1917–Dec. 31, 1917				
Jan. 1, 1918–Dec. 31, 1918				
Jan. 1, 1919–Dec. 31, 1919	21,513	4,003	1,138.28	28.44
Jan. 1, 1920–June 30, 1920	22,110	3,219	1,036.00	32.1[illegible]
Phenylenediamine:				
Jan. 1, 1917–Dec. 31, 1917				
Jan. 1, 1918–Dec. 31, 1918				
Jan. 1, 1919–Dec. 31, 1919	2,746	1,769	334.00	18.[illegible]
Jan. 1, 1920–June 30, 1920	•2,429	1,887	345.00	18.2[illegible]
Resorcin:				
Jan. 1, 1917–Dec. 31, 1917	134	672	104.00	15.[illegible]
Jan. 1, 1918–Dec. 31, 1918				
Jan. 1, 1919–Dec. 31, 1919				
Jan. 1, 1920–June 30, 1920	5,159	2,642	525.00	19.[illegible]
Anilin salt:				
Jan. 1, 1917–Dec. 31, 1917				
Jan. 1, 1918–Dec. 31, 1918	21,273	3,250	1,019.00	31.3[illegible]
Jan. 1, 1919–Dec. 31, 1919				
Jan. 1, 1920–June 30, 1920				
Benzylchloride:				
Jan. 1, 1917–Dec. 31, 1917	5	7	1.00	16.[illegible]
Jan. 1, 1918–Dec. 31, 1918				
Jan. 1, 1919–Dec. 31, 1919	1,000	430	89.50	20.81
Jan. 1, 1920–June 30, 1920	150	22	7.05	
Alldistillates, n. s. p. f., which on distillation yield in the portion distilling below 200° C. a quantity of tar acids equal to or more than 5 per cent of the original distillate:				
Jan. 1, 1917–Dec. 31, 1917				
Jan. 1, 1918–Dec. 31, 1918	1,550	2,008	339.95	16.[illegible]
Jan. 1, 1919–Dec. 31, 1919	3,170	4,587	767.30	16.73
Jan. 1, 1920–June 30, 1920	22,399	18,423	3,323.00	18.0[illegible]
Allsimilar products obtained, derived, or manufactured in whole or in part from the products provided for in Group I (free):				
Jan. 1, 1917–Dec. 31, 1917	193,021	17,595	7,465.00	42.43
Jan. 1, 1918–Dec. 31, 1918	13,445	8,640	1,632.12	18.89
Jan. 1, 1919–Dec. 31, 1919	51,214	39,861	7,259.50	18.21
Jan. 1, 1920–June 30, 1920	38,575	35,463	6,284.00	17.72

TABLE 17b.—*Imports of coal-tar products entered for consumption, Jan. 1, 1917, to June 30, 1920*—Continued.

GROUP III (DUTIABLE AT 30 PER CENT AD VALOREM).

	Quantity.	Value.	Duty.	Actual and computed ad-valorem rate.
When obtained, derived, or manufactured in whole or in part from any of the products provided for in Group I (free) or II, including natural indigo and their derivatives:				
Alizarin, natural—	*Pounds.*			*Per cent.*
Jan. 1, 1917–Dec. 31, 1917	6,899	$12,216	$3,665.00	30.00
Jan. 1, 1918–Dec. 31, 1918	108,711	158,816	47,644.80	30.00
Jan. 1, 1919–Dec. 31, 1919	6,684	8,612	2,583.60	30.00
Jan. 1, 1920–June 30, 1920	.....	.....	.....	.....
Alizarin, synthetic—				
Jan. 1, 1917–Dec. 31, 1917	19,180	55,179	16,554.00	30.00
Jan. 1, 1918–Dec. 31, 1918	.....	.....	.....	.....
Jan. 1, 1919–Dec. 31, 1919	.....	.....	.....	.....
Jan. 1, 1920–June 30, 1920	58,810	18,785	5,636.00	30.00
Dyes obtained, derived, or manufactured from alizarin—				
Jan. 1, 1917–Dec. 31, 1917	34	75	22.50	30.00
Jan. 1, 1918–Dec. 31, 1918	6,446	13,399	4,019.70	30.00
Jan. 1, 1919–Dec. 31, 1919	1,920	3,864	1,159.20	30.00
Jan. 1, 1920–June 30, 1920	17,777	6,220	1,866.00	30.00
Dyes obtained, derived, or manufactured from anthracene and carbazol—				
Jan. 1, 1917–Dec. 31, 1917	23,146	11,326	3,398.00	30.00
Jan. 1, 1918–Dec. 31, 1918	12,827	20,087	6,026.10	30.00
Jan. 1, 1919–Dec. 31, 1919	7,162	7,772	2,331.60	30.00
Jan. 1, 1920–June 30, 1920	29,275	60,760	18,228.00	30.00
Indigoids, whether or not obtained from indigo—				
Jan. 1, 1917–Dec. 31, 1917	129,983	140,932	42,280.00	30.00
Jan. 1, 1918–Dec. 31, 1918	3,376	13,744	4,123.20	30.00
Jan. 1, 1919–Dec. 31, 1919	34,049	82,779	24,833.70	30.00
Jan. 1, 1920–June 30, 1920	38,372	99,198	29,759.00	30.00
Flavors—				
Jan. 1, 1917–Dec. 31, 1917	35	408	122.00	30.00
Jan. 1, 1918–Dec. 31, 1918	160	816	244.80	30.00
Jan. 1, 1919–Dec. 31, 1919	.....	.....	.....	.....
Jan. 1, 1920–June 30, 1920	.....	.....	.....	.....
Indigo, natural—				
Jan. 1, 1917–Dec. 31, 1917	2,261,122	4,230,510	1,269,153.00	30.00
Jan. 1, 1918–Dec. 31, 1918	1,637,914	2,007,958	602,387.40	30.00
Jan. 1, 1919–Dec. 31, 1919	234,991	285,925	85,777.50	30.00
Jan. 1, 1920–June 30, 1920	20,574	33,831	10,149.00	30.00
Indigo, synthetic—				
Jan. 1, 1917–Dec. 31, 1917	1,379,249	871,267	261,380.00	30.00
Jan. 1, 1918–Dec. 31, 1918	660,414	342,589	102,776.70	30.00
Jan. 1, 1919–Dec. 31, 1919	537,697	327,133	98,139.90	30.00
Jan. 1, 1920–June 30, 1920	99,419	115,672	33,702.00	30.00
Medicinals—				
Jan. 1, 1917–Dec. 31, 1917	.....	284,346	85,304.00	30.00
Jan. 1, 1918–Dec. 31, 1918	.....	301,074	90,322.20	30.00
Jan. 1, 1919–Dec. 31, 1919	.....	168,466	50,539.80	30.00
Jan. 1, 1920–June 30, 1920	.....	63,813	19,144.00	30.00

GROUP III (DUTIABLE AT 30 PER CENT AD VALOREM PLUS 5 CENTS PER POUND).

When obtained, derived, or manufactured in whole or in part from any of the products provided for in Group I (free) or II, including natural indigo and their derivatives:				
Colors, or color lakes obtained, derived, or manufactured from alizarin—	*Pounds.*	*Dollars.*	*Dollars.*	*Per cent.*
Jan. 1, 1917–Dec. 31, 1917	7,062	18,680	5,957.00	31.89
Jan. 1, 1918–Dec. 31, 1918	1,499	4,490	1,421.95	31.67
Jan. 1, 1919–Dec. 31, 1919	15,358	14,405	5,089.40	35.33
Jan. 1, 1920–June 30, 1920	9,061	7,387	2,669.00	36.13
Colors, or color lakes obtained, derived, or manufactured from antracene and carbazol—				
Jan. 1, 1917–Dec. 31, 1917	53,205	49,729	17,579.00	35.35
Jan. 1, 1918–Dec. 31, 1918	27,900	22,546	8,158.80	36.19
Jan. 1, 1919–Dec. 31, 1919	38,073	55,475	18,546.15	33.43
Jan. 1, 1920–June 30, 1920	40,991	42,122	14,686.00	34.87

TABLE 17b.—*Imports of coal-tar products entered for consumption, Jan. 1, 1917, to June 30, 1920*—Continued.

GROUP III (DUTIABLE AT 30 PER CENT AD VALOREM PLUS 5 CENTS PER POUND—Continued.

	Quantity.	Value.	Duty.	Actual and computed ad-valorem rate.
When obtained, derived, or manufactured in whole or in part from any of the products provided for in Group I (free) or II, including natural indigo and their derivatives—Continued.				
All other colors, dyes, or stains, whether soluble or not in water, color acids, color bases, or color lakes—				
Jan. 1, 1917–Dec. 31, 1917	*Pounds.*	*Dollars.*	*Dollars.*	*Per cent.*
Jan. 1, 1918–Dec. 31, 1918 [1]	2,257,476	2,574,363	885,183.00	34.38
Jan. 1, 1919–Dec. 31, 1919	1,799,467	2,161,799	738,513.05	34.16
Jan. 1, 1920–June 30, 1920	1,991,687	2,848,294	954,072.55	33.50
Phenolic resin, synthetic—	1,368,604	1,813,211	612,394.00	33.77
Jan. 1, 1917–Dec. 31, 1917	134,702	11,596	10,214.00	88.09
Jan. 1, 1918–Dec. 31, 1918	.....	.....	.....	.....
Jan. 1, 1919–Dec. 31, 1919	1,114	2,860	913.70	31.95
Jan. 1, 1920–June 30, 1920	1,530	949	361.20	38.05
Photographic chemicals—				
Jan. 1, 1917 Dec. 31, 1917	12,632	101,406	31,053.00	30.62
Jan. 1, 1918–Dec. 31, 1918	14,550	108,537	33,288.60	30.67
Jan. 1, 1919 Dec. 31, 1919	12,059	77,876	23,965.75	30.77
Jan. 1, 1920–June 30, 1920	9,918	32,186	10,152.40	31.54

[1] Does not include 110 pounds, valued at $322, duty $81.68, from Cuba.

TABLE 18.—*General imports of coal-tar products, by countries, for calendar years 1918[1]–June 30, 1920.*

DEAD OR CREOSOTE OIL (FREE).

Imported from—	1918		1919		Jan. 1, 1920–June 30, 1920.	
	Quantity.	Value.	Quantity.	Value.	Quantity.	Value.
	Gallons.		*Gallons.*		*Gallons.*	
England	.....	.....	8,934,045	$1,085,617	2,551,835	$318,644
Scotland	1,125	$862	60,756	10,462	63,934	9,476
Canada	1,543,660	161,693	2,273,578	278,138	608,324	86,541
All other	462	314	.....	.....	2,015,130	[2] 382,575
Total	1,545,247	162,869	11,268,379	1,374,217	5,239,223	799,536

[1] Imports not available for 1917 calendar year.

[2] All from Netherlands.

CARBOLIC ACID.

Imported from—	1918				1919	
	Carbolic acid, free.		Carbolic acid, dutiable (phenol).		Carbolic acid, free.	
	Pounds.	Value.	Pounds.	Value.	Pounds.	Value.
England	155,236	$17,260	208,037	$54,884	1,619,823	$138,820
Canada	.....	.....	75,300	7,613	.....	.....
Scotland	.....	.....	.....	.....	345,466	28,965
Total	155,236	17,260	283,337	62,497	1,965,289	167,785

... AND COAL-TAR CHEMICALS.

... by countries, for the ...

...

...

...	1918	1919		Jan. 1, 1920, to June 30, 1920	
		Quantity.	Value.	Quantity.	
		Pounds.		*Pounds.*	
...	...	39	$2,517	218	
...	...	23,417	21,264	2,140	
...	...	215	411	9	
...	...	...	...	...	
...	266	25	265	29	
Total	...	...	...	...	

COAL-TAR COLORS OR DYES DUTIABLE.

...	1918	1919		Jan. 1, 1920, to June 30, 1920	
	Value.	Quantity.	Value.	Quantity.	
		Pounds.		*Pounds.*	
Belgium		30,998	$82,179	139,521	
France	$75,346	11,745	30,855	8,555	
Germany		183,731	93,365	205,684	
Switzerland	1,762,906	1,264,199	2,176,463	891,265	1,412
England	561,000	64,[illegible]	664,548	155,734	
All other	69,346	165,[illegible]	140,731	35,416	
Total	2,469,439	2,215,397	3,169,276	1,456,175	

TABLE 19.—Domestic exports of coal tar and of dyes and dyestuffs for calendar years 1918[1]–June 30, 1920.

COAL TAR.

Exported to—	1918		1919		Jan. 1, 1920, to June 30, 1920.	
	Quantity.	Value.	Quantity.	Value.	Quantity.	Value
	Barrels.		*Barrels.*		*Barrels.*	
Europe	2,069	$12,297	230	$900	214	$1,1
North America	54,149	139,[illegible]76	71,749	158,205	26,534	72,7
South America	808	6,2[illegible]8	2,759	20,166	2,470	13,9
Asia	198	1,505	475	3,174	10	
Oceania	154	1,739	45	301	34	
Africa	1,176	7,435	1,334	15,757	17	1
Total	58,554	168,720	76,592	198,503	29,579	8[illegible]

[1] Exports not available for 1917 calendar year.

TABLE 19.—*Domestic exports of coal tar and of dyes and dyestuffs for calendar years 1918–June 30, 1920*—Continued.

DYES AND DYESTUFFS (VALUE).

Exported to—	Calendar years.					
	1918			1919		
	Aniline dyes.	Logwood extracts.	All other.	Aniline dyes.	Logwood extracts.	All other.
Portugal	$176,769	$10,541	$131,280	$70,296	$2,319	$36,063
Belgium				90	34,787	19,193
France	6,345	263,610	496,875	127,059	596,042	229,689
Germany				150	290	
Italy	274,903	70,237	234,238	269,130	58,716	180,359
Netherlands				26,284	21,735	9,104
Russia			12,825	8,570		
Switzerland	22,500	7,728	5,000	193	22,824	
United Kingdom	380,181	345,458	524,576	413,700	304,686	423,719
Canada	836,445	82,292	724,522	1,015,334	119,871	1,007,892
Mexico	289,327	5,666	181,020	467,806	17,438	230,359
Central America	5,617	400	5,498	5,941	892	14,544
West Indies	23,447	742	35,473	34,307	137	40,900
South America	1,719,408	128,645	931,600	1,651,872	66,099	585,127
Asia	4,248,367	504,542	2,720,399	5,565,053	48,063	1,921,202
Oceania	100,490	20,194	133,493	177,964	14,041	143,223
Africa	3,993	715	15,534	45,566	1,508	8,281
Denmark			1,055	5,334	9,671	2,438
Spain	518,895	104,748	472,222	535,383	18,349	84,544
Sweden				22,694	8,584	15,708
Norway		985	4,529	13,663	1,300	7,303
All other	22,924	4,877	6,761	267,682	8,584	44,730
Total	8,629,611	1,551,380	6,636,099	10,724,071	1,355,936	5,004,428

DYES AND DYESTUFFS (VALUE).

Exported to—	Jan. 1–June 30, 1920.		
	Aniline dyes.	Logwood extracts.	All other.
Portugal	$34,789	$1,840	$6,240
Belgium	214,693	92,200	30,788
France	369,693	360,773	230,235
Germany	404	66	7,369
Italy	281,249	166,255	191,452
Netherlands	22,254	34,133	44,659
Russia (European)	100		
Switzerland	48,334	18,965	64,592
United Kingdom	558,510	393,117	518,599
Canada	888,420	81,621	538,836
Mexico	527,991	4,021	114,575
Central America	7,031	726	6,642
West Indies	22,183	2,014	56,678
South America	900,829	16,938	277,907
Asia	7,317,211	187,609	2,216,568
Oceania	96,410	1,016	70,762
Africa	32,027	1,350	21,670
Denmark	6,620	22,574	2,130
Spain	418,878	1,250	101,068
Sweden	6,268	1,110	12,663
Norway	1,710	20,251	9,964
All other	61,139		27,962
Total	11,816,743	1,415,709	4,551,359

TABLE 20.—*Inks and ink powders.*

(A) IMPORTS FOR CONSUMPTION, 1918 [1]–JUNE 30, 1920.

Calendar year.	Printer's ink.				Writing and copying ink.				All other, including ink powders.			
	Rate of duty.	Value.	Duty collected.	Actual and computed ad valorem rate.	Rate. of duty.	Value.	Duty collected.	Actual and computed ad valorem rate.	Rate of duty.	Value.	Duty collected.	Actual and computed ad valorem rate.
	Per ct.			*Per ct.*	*Per ct.*			*Per ct.*	*Per ct.*			*Per ct.*
1918	15	$4,154	$623	15	15	$13,363	$2,004	15	15	$6,343	$951	15
1919	15	199	30	15	15	15,116	2,267	15	15	8,143	1,221	15
1920 (6 months)	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....

(C) DOMESTIC EXPORTS OF PRINTER'S INK AND ALL OTHER INKS, 1918 [1]–JUNE 30, 1920.

Exported to—	Calendar years.				1920 (6 months).	
	1918		1919			
	Printer's ink.	All other inks.	Printer's ink.	All other inks.	Printer's ink.	All other inks.
Europe	$48,394	$25,371	$210,482	$68,362	$118,174	$49,653
North America	256,507	206,360	320,008	297,959	183,910	158,559
South America	353,023	100,833	603,758	210,212	218,626	90,054
Asia	224,345	67,736	435,664	155,420	323,975	101,525
Oceania	116,424	42,452	113,288	109,962	79,574	43,270
Africa	42,189	5,429	29,726	14,282	4,944	4,354
Total	1,040,882	448,181	1,712,926	856,217	929,203	447,715

[1] Figures for 1917 not available.

Directory of manufacturers of coal-tar products during 1919.

[The list below includes all firms that reported to the Tariff Commission the production of coal-tar products during 1919, except 56 that objected to the publication of their names. These 56 firms, almost without exception, are either out of business at the present time or manufacture coal-tar products for their own consumption and not for sale. Included among these 56 firms are firms engaged, primarily, in the manufacture of textiles, soap, rubber goods, perfumes, and inks. Coke-oven plants and gas houses which reported to the Geological Survey and not to the Tariff Commission are not included. The list includes manufacturers of crudes, intermediates, dyes, lakes, medicinals, flavors, photographic chemicals, synthetic phenolic resins, and synthetic tanning materials.]

No.	Name of company.	Office address (location of factory given in parentheses if not in same city as the office).
1	The Abbott Laboratories	4753 East Ravenswood Avenue, Chicago, Ill.
2	Acme Dyestuff Co	133 Maiden Lane, New York, N. Y. (Metuchen, N. J.).
3	Agawam Chemical Works (Inc.)	531 Grosvenor Building, Providence, R. I. (North Attleboro, Mass.).
4	Althouse Chemical Co. (Inc.)	540 Pear Street, Reading, Pa.
5	Amalgamated Dyestuff & Chemical Works.	75 Hudson Street (New York, N. Y.) (Newark, N. J.).
6	American Aniline Products (Inc.)	80 Fifth Avenue, New York, N. Y. (Lockhaven, Pa.).
7	American Chemical Works	1030 Folsom Street, San Francisco, Calif.
8	American Nitration Co. (Inc.)	River Road, Nutley, N. J.
9	American Tar Products Co.	208 South La Salle Street, Chicago, Ill. (St. Louis, Mo., Youngstown, Ohio, Woodward, Ala., Carrollville, Wis., Follansbee, W. Va.).
10	Ansbacher & Co., A. B	527 Fifth Avenue, New York, N. Y.
11	Anthrakone Dye Products & Chemical Co. (Inc.).	1834 Broadway, New York, N. Y. (Jersey City, N. J.).
12	Georgia Railway & Power Co	75 Marietta Street, Atlanta, Ga.

Directory of manufacturers of coal-tar products during 1919—Continued.

No.	Name of company.	Office address (location of factory given in parentheses if not in same city as the office).
13	Atlantic Dyestuff Co	88 Ames Building, Boston, Mass. Burrage Mass.)
14	Atlas Color Works (Inc.)	322 Ninth Street, Brooklyn, N. Y.
15	The Barrett Co	17 Battery Place, New York N. Y. (refinery, Frankford, Pa.).
16	Bayway Chemical Co	81 Fulton Street, New York, N. Y. (Elizabeth, N. J.).
17	Beaver Chemical Co	Damascus, Va.
18	Beaver Manufacturing Co	Ballardvale, Mass.
19	Bennett & Davis (Inc.)	327 South La Salle Street, Chicago, Ill.
20	British-American Corporation of New Jersey.	109 Beekman Street, New York, N. Y. (Ridgefield Park, N. J.).
21	Brooklyn Color Works (Inc.)	601 Sackett Street, Brooklyn, N. Y.
22	Bulls Ferry Chemical Co	Edgewater, N. J. (Shadyside, N. J.).
23	Butterworth-Judson Corporation	61 Broadway, New York, N. Y. (Newark, Lyndhurst, N. J.).
24	Calco Chemical Co	Bound Brook, N. J. (Burlington, Newark, Jersey City, Woodbridge, N. J.).
25	Philip Carey Manufacturing Co	Lockland, Ohio.
26	Carus Chemical Co	La Salle, Ill.
27	Central Dyestuff & Chemical Co	Plum Point Lane, Newark, N. J.
28	Certainteed Products Corporation	1801 Boatman's Bank Building, St. Louis, Mo. East St. Louis, Ill.).
29	Certified Chemical Corporation	246 Plymouth Street, Brooklyn, N. Y.
30	Chatfield Manufacturing Co	Seventy-fourth and Lebanon Streets, Cincinnati, Ohio.
31	Chemical Co. of America (Inc.)	176 Front Street, New York, N. Y. Springfield, N. J.).
32	Chemical Products Laboratories	Belleville, Ill.
33	Chemical Products Corporation	104 Thirty-second Street, Milwaukee, Wis.
34	Charles M. Childs & Co. (Inc.)	43 Summit Street, Brooklyn, N. Y.
35	Clifton Chemical Laboratories	Clifton, N. J.
37	Color Co. of America	14 Cedar Street, New York, N. Y. (Valley Stream, N. Y.).
38	Commonwealth Chemical Corporation	15 Park Row, New York, N. Y. (Newark, N. J.).
39	Condensite Co. of America	Bloomfield, N. J. (Wyandotte, Mich.).
40	Consolidated Color & Chemical Co	122 Hudson Street, New York, N. Y. Newark, N. J.).
41	Coopers Creek Chemical Co	West Conshohocken, Pa.
43	Croton Color & Chemical Co. (Inc.)	293 Broadway, New York, N. Y. (Croton, N. Y.).
44	Cumberland Chemical Corporation	Bristol, Va.
45	Davis Chemical Corporation, Everly M.	25 West Forty-fourth Street, New York, N. Y. (Union, N. J.).
46	Denver Gas & Electric Light Co	900 Fifteenth Street, Denver, Colo.
47	Dermatological Research Laboratories	1720 Lombard Street, Philadelphia, Pa.
48	Devoe & Raynolds (Inc.)	101 Fulton Street, New York, N. Y. (Brooklyn, N. Y.).
49	Dicks, David Co. (Inc.)	19 North Moore Street, New York, N. Y.
50	Dicks, David & Heller Co	Chicago Heights, Ill.
51	Dissosway-Schad Co. (Inc.)	830 Humbolt Street, Brooklyn, N. Y. (55 Eckford Street, Brooklyn, N. Y.).
52	Dow Chemical Co., The	Midland, Mich.
53	DuPont de Nemours & Co., E. I	Wilmington, Del. (Penns Grove, N. J.).
54	Dye Products & Chemical Co. (Inc.)	200 Fifth Avenue, New York, N. Y. (Newark, N. J.).
56	Eakins (Inc.), J. S. & W. R	24 Wallabout Street, Brooklyn, N. Y.
57	Eastman Kodak Co	343 State Street, Rochester, N. Y.
58	Essex Aniline Works (Inc.)	88 Broad Street, Boston, Mass. (South Middleton, Mass.).
59	Exedol Laboratories (Inc.)	Edgewater, N. J.
60	Fine Colors Co. (Inc.)	21-29 McBride Avenue, Paterson, N. J.
61	Florasynth Laboratories (Inc.)	Unionport, N. Y.
62	Gary Chemical Co	735 Broadway, Gary, Ind. (Chesterton, Ind.).
63	Goodyear Tire & Rubber Co	Akron, Ohio.
64	Grasselli Chemical Co., The	Cleveland, Ohio (Rensselaer, N. Y.).
65	Haarmann-de-Lair-Schaefer Co	Maywood, N. J.
66	Harmer Laboratories Co	1704 Market Street, Philadelphia, Pa.
67	Helena Light & Railway Co	Helena, Mont.
68	Helkulin Chemical Co	900 Jefferson Street, Hoboken, N. J.
69	Heller & Merz Co	Newark, N. J.
70	Morris Hermann & Co	788 President Street, Brooklyn, N. Y. (Newark, N. J.).
72	Heyl Laboratories, The (Inc.)	437 Barretto Street, New York, N. Y.
73	Hind Harrison Plush Co., The	Clark Mills, N. Y.
74	Holland Aniline Co	Holland, Mich.
75	Holliday-Kemp Co. (Inc.)	Betts Avenue and Queens Boulevard, Woodside, Long Island.
76	Hooker Electro-Chemical Co	40 Wall Street, New York, N. Y.
77	Hord Color Products Co	Sandusky, Ohio.
78	Hub Dyestuff & Chemical Co	595 East Seventh Street, South Boston, Mass.
79	Huron Chemical Co	100 Fifth Avenue, New York, N. Y. (51 Berren Street, Brooklyn, N. Y.).
80	Hydrocarbon Chemical Products Co	35 Cottage Avenue, Lancaster, Pa.
81	Hynson, Westcott & Dunning	Charles and Franklin Streets, Baltimore, Md.
83	Independent Coal Tar Co	26 Broad Street, Boston, Mass. (Taunton, Mass.).
84	Industrial Chemical Co	P. O. Box 1286, Providence, R. I.
85	International Consolidated Chemical Corporation.	11 East Thirty-sixth Street, New York, N. Y. (Long Island City, N. Y.).
86	Iridescent Dyestuff & Color Co	326 Broadway, New York, N. Y. (567 Sheepshead Bay Road, Brooklyn, N. Y.).

Directory of manufacturers of coal-tar products during 1919—Continued.

No.	Name of company.	Office address (location of factory given in parenthe e if not in same city as the office).
83	K. & T. Chemical Corporation	100 Broadway, New York, N. Y. (Hillburn, N. Y.).
91	Kettle River Co	Madison, Ill.
92	Klipstein & Sons Co., E. C	644 Greenwich Street, New York, N. Y. (Chrome, N. J. South Charleston, W. Va.).
94	Koppers Products Co	Union Arcade, Pittsburgh, Pa.
95	Lamie Chemical Co	Huntington, W. Va.
96	Lasher & Co., F. G	104 Grove Street, Brooklyn, N. Y.
97	Lewis Manufacturing Co., F. J	2513 South Robey Street, Chicago, Ill. (Chattanooga, Tenn. Canal Dover, Ohio; Moline, Ill.).
98	Lindsay Light Co	161 East Grand Avenue, Chicago, Ill.
100	McKesson & Robbins (Inc.)	91 Fulton Street, New York, N. Y. (Brooklyn, N. Y.)
101	Mallinckrodt Chemical Works	3600 North Second Street, St. Louis, Mo.
102	Max Marx Color & Chemical Co	192 Coit Street, Irvington, N. J.
103	Massachusetts State Department of Health.	540 State House, Boston, Mass.
104	Merck & Co	45 Park Place, New York, N. Y. (Rahway, N. J.).
105	Merrimac Chemical Co	148 State Street, Boston, Mass. (North Woburn, Mass.)
106	Metz Laboratories, H. A. (Inc.)	122 Hudson Street, New York, N. Y. (Brooklyn, N. Y.)
107	Miller, J. Augustus	44 Bergen Street, Brooklyn, N. Y.
108	Monroe Drug Co	Fourth and Oak Streets, Quincy, Ill.
109	Monsanto Chemical Works	1800 South Second Street, St. Louis, Mo.
110	Montana Power Co	40 East Broadway, Butte, Mont.
111	National Ammonia Co. of Pennsylvania.	Philadelphia, Pa.
112	National Aniline & Chemical Co	21 Burling Slip, New York, N. Y. (Buffalo, N. Y.; Marcus Hook, Pa.; Wappinger Falls and Brooklyn, N. Y.).
113	Naugatuck Chemical Co	1790 Broadway, New York, N. Y. (Naugatuck, Conn.).
114	New England Chemical Manufacturing Co.	North Billerica, Mass.
115	New Haven Gas Light Co	80 Crown Street, New Haven, Conn.
116	Newport Chemical Works (Inc.)	1112 First National Bank Building, Milwaukee, Wis. (Carrollville, Wis.; Passaic, N. J.).
117	New York Color & Chemical Co	98 John Street, New York, N. Y. (Philadelphia, Pa.).
118	Niagara Alkali Co	Buffalo Avenue, Niagara Falls, N. Y.
119	Nitro Products Co., The	Eddy Building, Saginaw, Mich.
120	Noil Chemical & Color Co. (Inc.)	152 West One hundred and eighth Street, New York, N. Y.
121	Organic Products Corporation	301 Liberty Street, Schenectady, N. Y.
122	Palatine Aniline & Chemical Corporation.	176 Purchase Street, Boston, Mass. (Poughkeepsie, N. Y.)
123	Peerless Color Co. (Inc.)	Bound Brook, N. J.
124	Po Ambo Chemical Co	Matawan, N. J.
125	Radiant Dye & Color Works	2837 West Twenty-first Street, Brooklyn, N. Y.
126	Redmanol Chemical Products Co	636 West Twenty-second Street, Chicago, Ill.
127	Reliance Aniline & Chemical Co	15 William Street, New York, N. Y. (Poughkeepsie, N. Y.)
129	Republic Creosoting Co., The	1614 Merchants Bank Building, Indianapolis, Ind. (Seattle, Wash.; St. Louis Park, Minn.).
131	Rhodia Chemical Co	135 Cedar St., New York, N. Y. (New Brunswick, N. J.)
132	Rollin Chemical Corporation	Charleston, W. Va.
133	Philip Ruxton (Inc.)	220 West Forty-second Street, New York, N. Y. (37 Water Street, Brooklyn, N. Y.).
134	Semet Solvay Co	Syracuse, N. Y. (Solvay, N. Y.).
135	Seydel Manufacturing Co	66 Forest Street, Jersey City, N. J.
136	Sherwin-Williams Co	Cleveland, Ohio. (Kensington, Chicago, Ill.).
138	Sinclair & Valentine Co	611 West One hundred and twinty-ninth Street, New York, N. Y. (Edgewater, N. J.).
139	Special Materials Co. (Inc.)	140 Livingstone Street, Brooklyn, N. Y.
140	Staier Chemical Co. (Inc.)	81 Fulton Street, New York, N. Y. (Newark, N. J.).
141	Standard Chemical Co	West Fifth Street, Bayonne, N. J.
142	Sunbeam Chemical Co	Cable, Wis.
143	T. M. & G. Chemical Co	517 Cortland Street, Belleville, N. J.
144	T. Taylor	Newman, Ga.
145	Thatcher Electrochemical Co	254 North Tenth Street, Brooklyn, N. Y.
146	Tower Manufacturing Co. (Inc.)	326 Broadway, New York, N. Y. (Brooklyn, N. Y.).
147	Transatlantic Chemical Corporation	192 Broadway, New York, N. Y. (Linden, N. J.).
148	Trico Chemical Co. (Inc.)	502 Iroquois Building, Buffalo, N. Y.
149	Paul Uhlich	11 Cliff Street, New York, N. Y. (Brooklyn, N. Y.).
150	Ultro Chemical Corporation	41 Union Square, New York, N. Y.
151	Union Dye & Chemical Corporation	80 Fifth Avenue, New York, N. Y. (Kingsport, Tenn.)
152	United States Color & Chemical Co	93–95 Broad Street, Boston, Mass. (Ashland, Mass.).
153	University of Illinois	Urbana, Ill.
154	Universal Aniline Dyes & Chemical Co.	1010 Wells Building, Milwaukee, Wis.
155	Van Dyk & Co. (Inc.)	4–6 Platt Street, New York, N. Y. (Jersey City, N. J.).
156	Verona Chemical Co	Verona and Riverside Avenues, North Newark, N. J.
157	Walker Chemical Co., The	P. O. 1145, Pittsburgh, Pa.
158	Warner-Jenkinson Manufacturing Co	2526 Baldwin Street, St. Louis, Mo.
159	Washington Dye & Chemical Corporation	Davidson Building, Washington, D. C. (Alexandria, Va.)
160	Waugh Chemical Corporation	2 Rector Street, New York, N. Y. (Perth Amboy, N. J.).
161	Western Dry Color Co	Fifty-second and Wallace Streets, Chicago, Ill.